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ON THE MINUTE MEASUREMENTS OF MODERN SCIENCE.

By Alfred M. Mayer.

Article IV.

On the Spherometer.

The word spherometer means a *sphere-measurer*, for it is the instrument invented to measure the radius of a sphere; that is, the distance from the surface of a sphere to its center. This instrument was invented by the French optician De La Roue to measure the radii of lenses. This measure is one required by opticians, for if they know the radii of the spherical surfaces of a lens, and also the refracting power of the glass of which the lens is composed, they can predict the general action of the lens on rays of light which fall upon it, and thus arrive at a knowledge of the focal length of the lens. The problem presented is, however, generally the inverse of what we have stated; that is, the optician first determines the refracting power of the glass of which the lens is to be composed, and then computes the radii of the curved surfaces which will give to the lens certain required actions on the rays of light. The spherometer now is appealed to in the course of his work to ascertain if the curved surfaces are really what they should be. When we have come to the article, in which we will explain the manner of measuring the angles of a glass prism and of determining its refracting power, we will show how we can then compute those radii of curvature of a lens which will cause it to have a required focal length, and to produce definite actions on rays of light. Figure 7 is a drawing of the spherometer. It consists essentially of a micrometer-screw which runs through a nut mounted on a tripod. The screw, P, turns in the nut, N, which is supported on the three legs, A, B, C. The head, D, of the screw is divided into a certain number of equal parts. At I is an index on which is engraved a scale, each of whose parts equals the distance through which the point, P, of the screw moves when the latter is turned one whole revolution in its nut. At the same time the edge of the index, I, serves as a line from which is read on the divided head the fractions of the revolution of the screw.

Before beginning the description of the manner of determining with this instrument the radius of a lens, we will apply it to the measurement of the thickness of a glass plate. The instrument stands on a plate of glass whose surface is as flat as can be obtained. When the point of the screw just touches the glass plate, then it is evident that the screw-point and the three points on the tripod legs are in one plane, which plane is the plane of the surface of the glass plate. But the central screw-point may press more or less on the glass than any one of the tripod points, and as the materials of the screw and the glass are elastic and yielding, the point may be either above or below the plane in which are the points of the tripod. Yet if we can be sure that the point of the screw presses in successive measures always with *the same pressure* on the plate, then it evidently matters not if the point of the screw be above or below the surface on which rest the tripod-points. To obtain this similarity of contact of the screw in different measures, various contrivances have been applied to the spherometer. I have myself used the instrument furnished with the contact-lever, the contact-level, and with the electric-contact. These additions to the spherometer, however, greatly increase its cost, and place it beyond the power of many to possess this remarkable instrument. The writer has, by a very simple method, succeeded in rendering any ordinary spherometer exceedingly delicate in its contacts. I place the glass plate of the spherometer, as shown in Fig. 7, on a box shaped like a cigar-box, but with one end of the box removed, and with the top of the box glued on. Contacts of the screw-point with the plate and with the body to be measured are made in this manner. The screw is turned downwards till it evidently touches the glass plate. When the plate, which rests on the box, is tapped with the finger, generally it will be found that the screw-point has been forced too far down, for the spherometer *rattles* when the glass plate is quickly tapped. Now slowly turn the screw upwards till the rattle *just* disappears. We take this position of the screw-point as its point of contact, and make several determinations of it, and after each adjustment we take the reading on the screw-head and on the index. The number thus found is sometimes called the zero point of the instrument, for from the point of the screw, when its head has the above reading, is measured the distances which the instrument determines. The writer has found from a series of careful experiments, recently made, that the range of error in obtaining the zero point of the above method does not exceed the $\frac{1}{5000}$th of an inch.

To measure the thickness of a plate we proceed as follows: The zero point of the instrument is first carefully determined. Then the screw is turned upwards sufficiently to allow the plate to be placed under it. The screw is now rotated so that its point comes down on the surface of the plate, and then the glass plate on which the spherometer rests is rapidly and gently tapped. If no rattle occurs, the screw is turned further downwards till one is perceived. Then the screw is rotated upwards until the rattle just disappears. The reading is now obtained from the index and the screw-head, and the difference between this reading and the zero-point reading gives the thickness of the plate in revolutions and fraction of revolution of the screw; this number multiplied by the pitch of the screw in inches or millimetres gives the thickness of the plate in inches or millimetres.

With this instrument we may also measure the diameter of fibres of wool, silk, hair, etc., in this manner: We take two plates of flat glass, and placing one of them on the other, we measure the sum of their thicknesses in the same manner as we above measured the thicknesses of one plate. A number of the fibres to be measured are now stretched across one of the plates, and their ends cemented to its sides. The other plate is now placed on the one carrying the fibres, and the thickness of the plates, as now determined, will equal the diameter of the fibres added to the thickness of the plates as previously determined. The first measure subtracted from the second gives the diameter of the fibres. Quite a number of fibres should be stretched across the plate, so as to give sufficient lines of support to prevent the weight of the upper plate and the pressure of the screw from compressing them, and thus giving them a smaller diameter than they really have.

To determine with the spherometer the radius of the spherical surface of a lens, we proceed as follows: The instrument is placed on the flat glass plate, and the reading of the index and screw head is obtained when the points of the tripod and the point of the screw are in the same plane. Then the screw is turned upwards and the instrument is placed on the lens, as shown in Fig. 8. The screw is now very gradually brought down on the convex surface of the lens, so that it just touches it, and so that no rattle is obtained when the lens is tapped. The difference between the reading of the screw now obtained, and the reading when the four points were in one plane, on the glass plate, gives us the distance x to y in Fig. 8. From this measure we can compute x to o, the radius of the lens, if we also have the distance y to a, or the length from the point of the screw to the circumference of the circle which passes through the points of the tripod. This distance is readily obtained as follows: The instrument is placed on a sheet of paper on a flat board, and with the points of the tripod and screw in the same plane we press the instrument down on the paper, and thus obtain the imprint of the four points of the instrument. The center of each of the above little circular points is now very accurately marked by the puncture of a needle point, and the distance from the center of the impress of the screw-point to the center of each of the tripod points is measured. The mean of these measures gives the distance a to y in the drawing.

The method of computing from these two measures the radius of the spherical surface of the lens is quite simple, and is readily explained by means of the lines drawn on Fig. 8. In Fig. 8, O is the center of the spherical surface of the lens; that is, $O\,x$ is the radius of the lens, and the problem is to find this distance when we know x to y and a to y. Twice $O\,x$, or the diameter of the lens, is to $a\,y$ as $a\,y$ is to $x\,y$. If the above geometrical truth has slipped the memory of our reader, he may find its proof in any work on geometry. Let h stand for $x\,y$, and r for $a\,y$, and R for O x. Then the above relation becomes as follows:

$$h : r :: r : 2\,R - h, \text{ hence } R = \frac{r^2}{2h} + \frac{h}{2}$$

That is, if we square the measure $a\;y$, and divide it by twice $x\;y$, and then add this quotient to the half of $x\;y$, we obtain the radius of the lens.

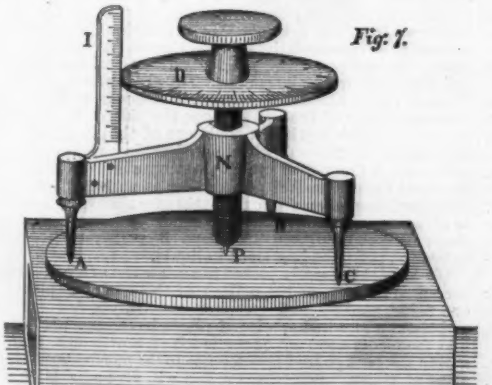
We will here give an example of an actual measure of the radius of a lens. The pitch of the screw of the instrument is one millimetre, or about $\frac{1}{25}$th of an inch. The distance from the center of the screw-point to the points of the tripod is 60·8 millimetres. The head of the screw is divided into 200 parts. On placing the instrument on the surface of a flat glass plate, and bringing the screw and tripod points to touch this surface, I found that the reading on the screw was 19 revolutions and 123 divisions of the screw-head. When the four points of the instrument just touched the surface of the lens, I obtain on the screw-head the reading 11 revolutions and 192 divisions of the screw-head. The last reading subtracted from the first gives 7 revolutions and 131 divisions of the screw-head for the length from x to y. Seven revolutions and 131 divisions of the screw-head equals 7·655 millimetres. Placing this number and also 60·8, the value of r, into the above formula, $R = \frac{r^2}{2h} + \frac{h}{2}$, we have:

$$R = \frac{60{\cdot}8^2}{2 \times 7{\cdot}655} + \frac{7{\cdot}655}{2} = 241.327 \text{ millimetres.}$$

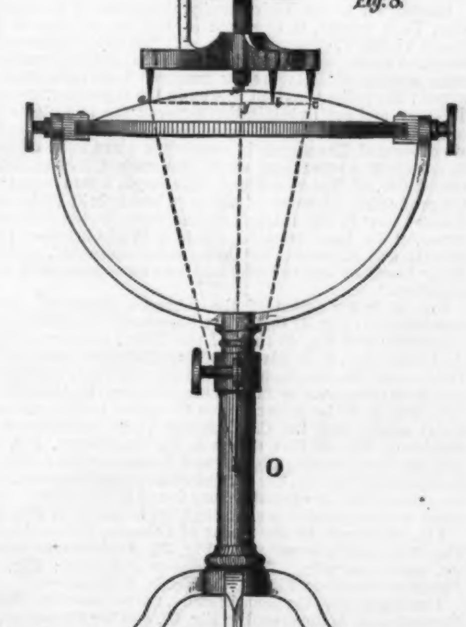
That is, the radius of curvature of this surface of the lens equals 241.327 millimetres.

The great defect of the spherometer, as usually constructed, is that one cannot measure with it the radius of curvature of a small lens, because the legs of the instrument are so far from the screw that they can only stand on a lens of large surface. The writer, some five years since, modified the ordinary instrument so that one can measure with it the radii of the curvature of small lenses. The instrument thus improved has its usefulness greatly increased, as the lenses whose radii of curvature we desire the oftener to know are lenses of small diameter.

Fig. 9 shows our addition to the spherometer. The three feet of the instrument rest in little cup-shaped depressions made in the top of the three short columns A, B, C. These columns rest on a brass plate, which is itself supported by the three legs D, E, F. In this brass plate is a hole into which screws the steel plate H H. In the center of this plate is a tube. This tube of steel is very accurately formed in a lathe, with a sharp edge, as shown in the figure. Against this edge of the tube the lens L is firmly pressed by the spring M. The point p of the screw S is accurately centred in the tube. This spherometer is furnished with the contact-lever, because the method of determining contacts as above described is not applicable to the instrument as now modified.



THE SPHEROMETER.



INSTRUMENT FOR MEASURING LENSES.

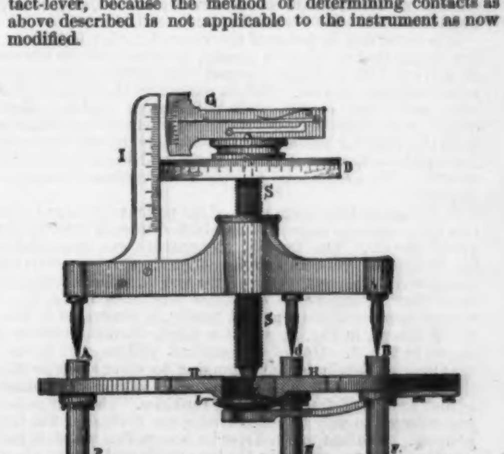


Fig. 9.—MAYER'S SPHEROMETER FOR MEASURING SMALL LENSES.

The method of using the apparatus is as follows: A small plate of flat glass is first placed on the bottom of the tube, and the spring is allowed to press this plate firmly against the tube. The screw is now rotated until its point touches the surface of this plate, and forces the contact-lever to the zero of its graduated arc G. The reading now obtained on the screw-head of the instrument gives the position of the plane l l of the mouth of the tube. The flat glass plate is now removed, and the lens L is substituted in its place, as shown in the figure. The screw-point is now brought down on the surface of the lens, and the difference between the reading now obtained on the screw and the previous reading gives the distance from the plane l l, passing through the lens to the uppermost point, *p*, of the surface of the lens. This distance corresponds to the distance *x* to *y* in Fig. 8. Half the interior diameter of the tube is equal to the length *a y* in Fig. 8. The computation of the radius of curvature of the lens from these measures is performed in exactly the same manner as has already been explained in connection with the instrument shown in Fig. 8.

It is a difficult operation to center accurately the point of the screw in the steel tube, so, instead of relying on this adjustment as having been accurately made, the operator may obtain the distance *x y* by moving the screw-point over the surface of the lens until he obtains the *greatest* measure possible. This measure evidently is the distance from *x* to *y*.

The instrument is furnished with plates carrying tubes of various diameters, which are screwed into the bed-plate of the instrument so as to suit the sizes of the lenses to be measured.

Thus the radii of lenses of very different diameters can be readily measured.

PRACTICAL VALUE OF THE MICROSCOPE.

IT is said that Professor Pasteur has saved enough to France by his discoveries to pay the indemnity to Germany. He is a great chemist, and one of the most skillful experimenters in the world. For many years he has been subjecting the theory of spontaneous generation to the most severe scientific tests, and is positive in his conviction that all life, so far as we know it, springs from living seed or germs. The experience of the best dealers in wine has been baffled in seeking a remedy for a difficulty. Professor Pasteur put some of the spoilt wine under the microscope, and soon discovered the cause of the trouble. Minute organisms were found in the wine in every instance, and the change of quality was due to their presence and growth. Of course they grew from germs, and if the germs could be destroyed the mischief would be averted. Judging from experiments in other liquids that heat would be fatal to the germs, he subjected the wines to a degree of heat which they could bear without injury, and found that all the germs were destroyed. The wine makers profit by the science of the chemist, and save millions of dollars formerly lost by the spoiling of the wines. Having been successful in making wines unalterable, he turned his attention to vinegar. This was subject to changes, which made it putrid and worthless. He detected another kind of organism in vinegar, and taught the dealers how to destroy it in germ and keep the vinegar unharmed.

POLLEN.

By W. G. SMITH.

THE following notes have referred alone to the external form of a few typical pollen grains as seen under the microscope:

They are engraved direct from Nature to one uniform scale; all the figures are enlarged 400 diameters. A mere glance will show how extremely pollen grains or cells differ in size, in form, and in external marking; they also differ greatly in color, but from necessity the magnificent colors which they exhibit to the eye cannot be here reproduced. In nearly every instance the peculiar markings or reticulations on the cells are only partly indicated in these engravings (to save labor); for instance in Fig. 5 the pattern is complete, whereas in 13 and 14 the peculiar markings are left unfinished for the reason mentioned. Pollen grains also differ very much from each other in their viscidity or dryness of surface, and in their density or translucency. As a rule, pollen grains are fairly constant in size and form in each botanical species of plant, but in long cultivated garden varieties and hybrids the pollen shows a great tendency to vary.

Mr. A. W. Bennett suggests that plants may be roughly divided into two classes—the class which has the pollen carried to the stigma by the agency of the wind, and the class which receives the pollen through the agency of insects. The first class is said, as a rule, to have flowers without ornamental form or beauty of color, and unfurnished with odors; the latter class is said to have bright colored and more or less scented flowers, attractive to insects. The pollen grain in the first class is said to be as a rule plain in form and easily carried by the wind; in the latter spiny or furnished with protuberances or furrows, to aid in its attachment to the limbs and bodies of insects. Generalizations are always dangerous, especially when made on a large scale, but in this instance Mr. Bennett's suggestion is undoubtedly supported by a large number of facts; there are, however, some striking exceptions.

It is never safe to judge of the character of pollen from a few grains shaken out of a corolla, as sometimes the interior of flowers will be found covered with pollen belonging to many different flowers. This is caused by the visits of flies, bees, and other insects, with pollen from various plants dusted over their bodies. Numerous natural hybrids arise from the visits of these pollen-dusted insects, and it is quite impossible to keep some garden varieties distinct on this very account. The ornamental gourds of our gardens form a case in point.

In the genus Œnothera most of the pollens are large in size and the grains are more or less attached to each other by fine viscid threads. The threads of necessity get entangled on the limbs of insects, and so the pollen is carried about and transferred in masses. One of the largest pollens known to us is that belonging to *Œnothera macrocarpa* (Fig. 1). A second member of the Onagrad family is illustrated in *Godetia Whitneyi*, in Fig. 2; whilst a third, *Clarkia pulchella* is shown in Fig. 3. One of the smallest pollens seen by us in the Onagrad family is that belonging to *Circæa alpina* (Fig. 4). Associated with these pollens in the anther it is common to find groups of free crystals or raphides. The four pollens just referred to may be considered quite typical of the Onagraceæ. The best marked species bear pollen which is most constant in form, whilst in the long cultivated garden plants, as the Fuchsia, the pollen is always variable.

Triangular pollens are by no means confined to the Proteaceæ family, as Fig. 5 represents the pollen of the common Honeysuckle, *Lonicera Periclymenum;* Fig. 6 that of *Erica Tetralix;* and Fig. 7 that of a Rhododendron, *R. Catawbiense*. Another member of the Erica family, *Clethra arborea*, Fig. 8, differs from the general form.

Few pollens are more interesting than those belonging to the Borage family. All we have seen are small, some quite minute, and all are more or less shaped like dumb-bells. Fig. 9 represents that of the common Comfrey, *Symphytum officinale*, Fig. 10 that of *Cerinthe bicolor*, Fig. 11 that of *Omphalodes linifolia*, and Fig. 12 that of *Echium vulgare*. The latter pollen is remarkable on account of its two lobes being always unequal, as shown.

Some members of the Acanthus family have beautiful pollen with peculiar markings. *Libonia floribunda* is represented at Fig. 13, and *Sericographis Ghiesbreghtiana* at Fig. 14. One of the most peculiar and handsome of all pollens is found in Thunbergia, another member of the Acanthus family, *T. Harrisii*, shown in Fig. 15.

Turning now to the Scrophularia family, *Mimulus moschatus* is shown in Fig. 16. I have placed this figure exactly under the Thunbergia pollen, to call attention to the singular error made by Van Mohl, who, in one of his plates, figures the former pollen for the latter. I have also thus engraved the figures to show how errors are perpetuated, for Mohl's illustration of *Mimulus moschatus* is reproduced in the "Micrographic Dictionary," "and in two other English works, without acknowledgment, and all wrong. The pollen of *M. moschatus* (a garden plant of long cultivation) is very variable. The pollen of one variety will be three times the size of another, or at times as big in size as the Thunbergia; but, though the same in size, they are always totally different in structure to an experienced eye. Still keeping to the Scrophularia family, Fig. 17 represents pollen of *Calceolaria Pavonii*, Fig. 18 that of the Foxglove, *Digitalis purpurea*, and Fig. 19 that of the Snapdragon, *Antirrhinum majus*.

Of the Euphorbia family, *Mercurialis annua* is illustraedt in Fig. 20, *Xylophylla glaucescens* in Fig. 21, and *Croton pictus* in Fig. 22.

Some of the finest of all pollens are to be found in the Mallow family. Fig. 23 belongs to *Hibiscus rosa-sinensis*, and Fig. 24 to *Abutilon Darwinii*. All the pollens as seen by us in this family present the same characters. The common Hollyhock, and the two common Mallows, *M. sylvestris* and *M. rotundifolia*, have especially fine pollen.

Many members of the Composite family have spiny pollens; that of *Dahlia cervantesii* is represented at Fig. 25, *Erigeron canadensis* at Fig. 26, *Centaurea cyanus* at Fig. 27. The latter, the pollen of Gazania, and of other members of the Composite family, considerably depart from the type, and, according as the plants approach or recede from the Dipsaceæ, the Valerianeæ, the Campanulaceæ, etc., so the pollens vary. Without doubt many valuable hints may yet be obtained from a careful examination of the fresh pollen of the Compositæ; sometimes the spines are very large. Mohl has represented the spines so thin as to be almost invisible in *Sonchus palustris*, and in the inaccurate, unacknowledged copies published in the "Micrographic Dictionary" and in other English books, the spines are simply omitted altogether, so giving a very false impression of the real character of the Sonchus pollen.

The Canterbury Bell, *Campanula Medium*, has echinulate pollen, as shown in Fig. 28. This pollen is a good general representative of the Campanula family. We know no more beautiful pollen than that belonging to the major Convolvulus, *Ipomæa purpurea*, Fig. 29. *Convolvulus (Calystegia) Soldanella* is shown in Fig. 30, and *Convolvulus arvensis* at Fig. 31. These three pollens, it will be seen, are very different from each other, and ought undoubtedly to carry weight with those systematic botanists who are in doubt as to the natural position of the genera in the Convolvulus family. The Dodders (*Cuscuta*) are sometimes placed in the Convolvulus family, and the pollen of *Cuscuta trifolii*, Fig. 32, is certainly the same in character with Fig. 31, *Convolvulus arvensis*.

The different members of the Arum family furnish beautiful and most peculiar pollen grains, of very diverse characters. Fig. 33 represents the pollen of *Phyllotænium mirabile*, Fig. 34 that of *Anthurium patinii;* this latter is a most extraordinary pollen, marked with projecting longitudinal ribs. Fig. 35 represents that of *Spathophyllum heliconiæfolium*, Fig. 36 that of *Anthurium Scherzerianum*, and Fig. 37 that of *Richardia albo-maculata*.

The pollen grains of the Lily family are very characteristic. Fig. 38 belongs to *Lilium longiflorum*, and is remarkable for its large size and its bold and beautiful reticulations. Fig. 39 is that of *L. Californicum*, where the reticulations are very much smaller. Fig. 40 is that of *Aloe Abyssinica*, Fig. 41 shows that of *Narthecium ossifragum*, that of Fig. 42 *Convallaria majalis*, and Fig. 43 that of the Crown Imperial, *Fritillaria imperialis*.

Passing on to the Violet family, the pollen of the Heartsease, *Viola tricolor*, is engraved at Fig. 44, and that of the Sweet Violet, *V. odorata*, at Fig. 45. Though coming under the same genus, and possessing many characters in common, in some species of Viola are far removed from each other in nature; the pollens, as will be seen in the engraving, are very different, and any hybridization between the two plants last referred to would appear to be quite hopeless, although a sweet scented Heartsease is certainly a plant to be desired. In answer to a letter from us on this subject, Messrs. Dicksons & Co., of Waterloo Place, Edinburgh, a firm noted for the production of some of the very best hybrid Violas and Pansies now in the market, replied to us in the following terms: "We have tried to obtain a hybrid between *Viola odorata* and *V. tricolor*, but have never succeeded, and we never heard of any one who had been more successful than ourselves."

Fig. 46 is the pollen of the tuberous Moschatel, *Adoxa moschatellina;* Fig. 47 that of the Snowberry, *Symphoricarpos parviflora;* and Fig. 48 that of the Elder, *Sambucus nigra*. As for the first, it is placed in Caprifoliaceæ both by Dr. Hooker and Mr. Bentham, in Araliaceæ by Prof. Babington, and in Saxifragaceæ by Linnæus and Jussieu. Unfortunately, very little is to be learned from the pollen in this instance, for it agrees with the Caprifoliaceæ in its resemblance to Sambucus, Fig. 48 (but differs in the Snowberry, Fig. 47, and the Honeysuckle, Fig. 5); and it agrees with Araliaceæ in resembling the Ivy, Fig. 73, and with the Saxifrages in being very much like the typical pollens found in this genus. *Saxifraga umbrosa* (which is characteristic) is shown at Fig. 49.

Fig. 50 belongs to the Cedar of Lebanon, *Cedrus Libani;* Fig. 51 to *Echeveria secunda;* Fig. 52, *Arundinaria falcata* (or, more correctly, *Thamnocalamus Falconeri*); Fig. 53, *Passiflora cælestina;* Fig. 54, the Nettle, *Urtica urens*.

Turning now to the Gourd family, the pollen of the Melon, *Cucumis melo*, is illustrated in Fig. 55, and the Cucumber, *C. sativus*, Fig. 56. Judging from the plants themselves, and the great similarity in the form and size of the pollen, it would appear quite possible to get a hybrid between the melon and the cucumber; and a well known instance is on record of a supposed intermediate fruit produced naturally in Mr. Watson's nursery at St. Albans. Before leaving the Gourds we may say the pollen of the Vegetable Marrow, *Cucurbita ovifera*, is totally different in character from the two last named, being two or three times larger in diameter, spherical in shape, and densely covered with spines. The Bryony of our hedges is again different from all three, but as large in size as the pollen or the cucumber.

The common Bitter-sweet, *Solanum dulcamara*, bears very small pollen grains, Fig. 57. The outline here engraved is a common form in the Solanum family.

The Polemonium family is remarkable for its truly handsome pollen. That belonging to *Phlox decussata* is illustrated at Fig. 58; *Cobæa scandens*, belonging to the same family, has a pollen about ten times the bulk of Phlox, and with similar elegant hexagonal reticulations.

Fig. 59 is a typical representative of the Amaryllis family in *Crinum pratense*, whilst Fig. 60 belongs to the common Snowdrop, *Galanthus nivalis*, and is the only departure from the typical form known to us in this family. Very little or nothing can be learned from a study of the pollens found in the genus Narcissus. The plants placed under this genus have been so often hybridized, and have been so long cultivated, that the pollens (like the plants themselves) vary exceedingly. One anther belonging to a Narcissus will commonly produce pollen grains of the most diverse sizes. Fig. 59 (Crinum) is typical for shape, but many grains in Narcissus are linear, while others are triangular, and both these occur in the same anthers with typical grains.

These latter remarks hold good with the species and varieties of Iris, as found in our gardens. Nothing can be made of the pollens of the mere garden forms, but that something may be learned from the study of the pollens of true species is shown by Fig. 61, which represents the pollen of *I. iberica*, and Fig. 62 the very differently formed pollen of *I. Kæmpferi*. These two forms, in good species of Iris, are both striking and constant. Gladiolus and Freesia have pollen similar in shape with Fig. 62. Fig. 63 belongs to *Crocus aureus*.

A great deal has been written as to possible hybrids between our wild Geraniums and our garden varieties, especially with a view to get a blue strain of color into the garden plants. As far as we know, all these attempts have proved abortive, and from a study of the pollens in the geranium family we are inclined to think that no such hybrids will ever be obtained. Fig. 64 is the pollen grain belonging to our little wild *Geranium sanguineum*, *G. Phæum* is the same in size, whilst *G. pratense* is much larger. On the other hand, Fig. 65 represents the pollen of *Pelargonium zonale*. In Mr. Turner's fine collection of Geraniums and Pelargoniums the pollens are very similar with the latter. In Pelargoniums the pollen grains are globular. In Oxalis, the genus Erodium the pollen grains are globular. In Oxalis, Fig. 66, *O. Acetosella*, and *Tropæolum*, Fig. 67, *T. majus*, the pollen grains agree well with the Geranium family, and in this respect they add additional weight to the conclusions arrived at by Messrs. Hooker and Bentham, who place these two genera in the Geraniaceæ.

The pollen grains of the Umbelliferæ are, as a rule, very characteristic. That of *Heracleum sphondylium* is shown at Fig. 68, *Œnanthe crocata* at Fig. 69, *Sium angustifolium* at Fig. 70. The curious genus Hydrocotyle has pollen similar with Fig. 71 in *H. bonariensis*, and with Fig. 72 in *H. nitidula*. The pollen of the common Ivy, *Hedera helix*, is shown at Fig. 73. Dr. Berthold Seemann proposed removing the genus Hydrocotyle from the Umbelliferæ to the Araliaceæ, but the characters of the pollen, as seen in many genera and species of the two families, hardly appear to us to support Dr. Seemann's views.

Fig. 74 is the pollen of the Bird's-foot, Trefoil, *Lotus corniculatus*. This may be considered representative of the Laguminosæ. Fig. 75 belongs to *Cytisus Laburnum*, whilst Fig. 76 is *Erythrina cristagalli*—a curious departure from the usual type.

Of the Labiate family, Fig. 77 belongs to *Nepeta violacea*, Fig. 78 to *Salvia patens*, and Fig. 79 to *Scutellaria Moccini-ana*. As far as our observation goes, these are the three salient and constant forms found in the Labiatæ.

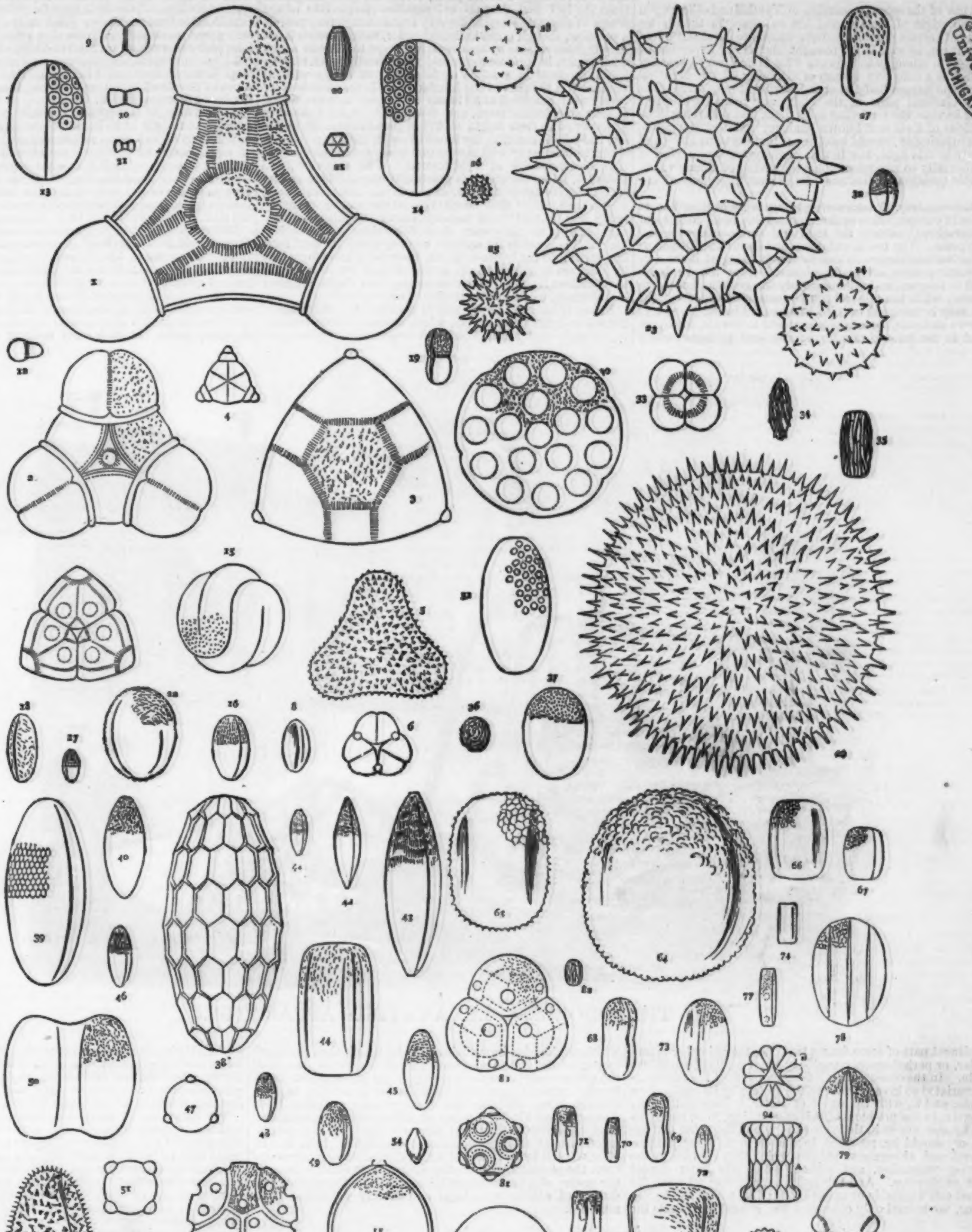
Fig. 80 is the pollen of *Epacris hyacinthiflora*, and Fig. 81 a highly ornamental pollen, belonging to *Fumaria officinalis*.

Turning now to the Primula family, *Primula viscosa* is illustrated in Fig. 82, *P. veris* in Fig. 83, and *P. denticulata* in Fig. 84. The latter is quite an exceptional form, the other two are characteristic of the family. The pollen of the common Primrose varies in size extremely, and the same fact holds good with the Cowslip and Polyanthus; in all three plants the pollen may at one time and place be eight times the bulk of what it is at a different place and in a different situation. Notwithstanding these variations, our *Primula vulgaris* is so different in its pollen from *P. japonica* that we consider the production of a true hybrid between the two plants very improbable. As far as our knowledge goes, no one has yet secured a true hybrid between *P. vulgaris* and *P. japonica*.

As an example of the pollens commonly found in the Plumbaginaceæ, Fig. 85 is given from *Armeria maritimi*. Fig. 86 is from the Holly, *Ilex aquifolium;* Fig. 87 belongs to the white Water Lily, *Nymphæa alba;* Fig. 88 is a pollen grain of *Papaver Rhœas*, and is a good representation of the Poppy family. Fig. 89 is the pollen of the Lime, *Tilia europæa*.

The pollens are all beautiful in the Pink family, Caryophyllaceæ. Fig. 90 represents the pollen of the Corn Cockle, *Agrostemma githago*, and Fig. 91 that of the Sweet William, *Dianthus barbatus*. In conclusion, Fig. 92 is engraved as a representative of the Cacteæ in *Opuntia polyantha*, the pollen grains being flat disks and not spheres; and Fig. 93 is from the common Teasel, *Dipsacus sylvestris*. The last pollen illustrated, Fig. 94, is *Polygala vulgaris;* two views are given of this pollen—one the side at A, the other the top at B; this is without doubt one of the most curious of all pollens. In the red, white, and purple varieties of *Polygala vulgaris* the pollen grains also vary a little in form. At the exact time of maturity this pollen is perfectly spherical, but after it has fallen from the anther for about five minutes, or at most a quarter of an hour, it suddenly collapses into the shape here figured, and this shape it permanently retains unless the pollen be immersed in liquid.

We have thus hastily passed in review the external aspects presented by some of the pollens of the common plants of our fields, gardens, and greenhouses. Only a few families and about a hundred species of plants have been noticed, so that the reader need not be reminded of how much there is still in the background in reference to the mere external form alone of pollen. Sometimes pollen will give a valuable clue to a plant's relationships, whilst at other times it will give no clue at all, or it points in various contrary directions. This is because plants have not descended one from another in a straight line, but possess complicated relationships with plants belonging to several different natural orders.—*Microscopical Journal.*

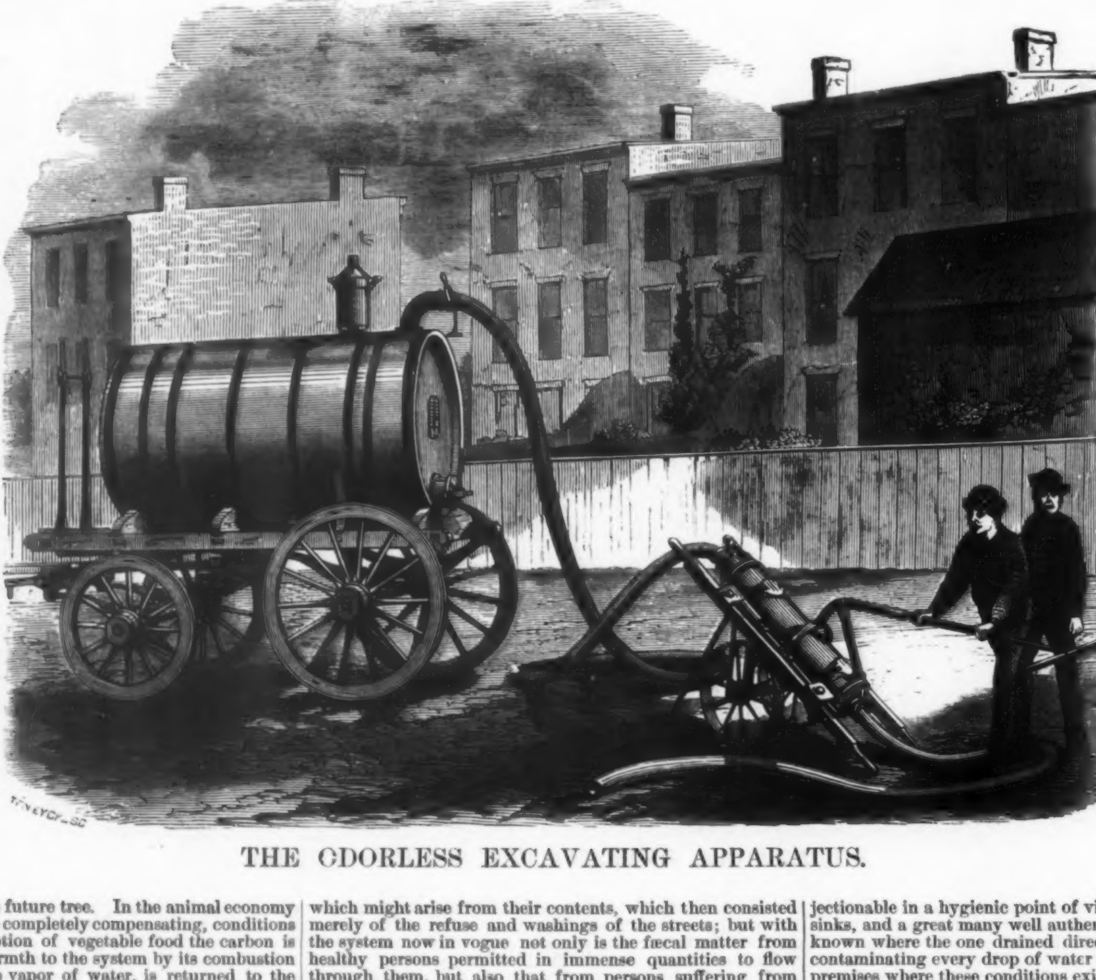


MICROSCOPIC DRAWINGS OF POLLEN, ENLARGED FOUR HUNDRED DIAMETERS. BY W. G. SMITH.

THE CENTENNIAL EXHIBIT OF THE ODORLESS EXCAVATING APPARATUS COMPANY, OF BALTIMORE.

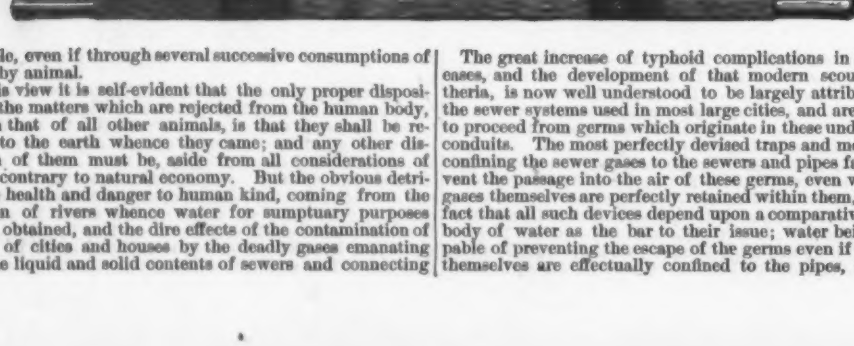
In view of the recent researches of Tyndall and others upon the germ origin of disease, and the existence in the air we breathe of certain organic matters which are supposed to engender them, as well as the thought and effort expended of late years in attempts to improve what is now very generally regarded as a defective system of disposing of the fæcal *rejecta* of the human body, such as obtains in most large cities of the civilized parts of the globe, any methods or plans having in view the rendering innocuous, and depriving these operations of their well known tendency to affect the public health injuriously, should be of great interest to us all. And not only in this light, but in that perhaps more powerful, if not inherently so important a one, the saving of money value, does this question become one of the most important of our day.

In the economy of nature everything is so ordained as to operate in compensating cycles, and results and products of one operation constitute the food and sustenance of a succeeding one. The tree is cut down and burned to furnish us heat for various purposes, and in the burning of it the carbonaceous portion originally obtained from the air is returned to it again, to feed and supply the growth of succeeding trees; while the mineral constituents obtained from the earth may be returned to it, to be absorbed in the growth of the new; and even the water is returned to the air, to be condensed in the form of rain, to nourish and perhaps form a constituent part of some future tree. In the animal economy similar, or perhaps more completely compensating, conditions obtain. In the consumption of vegetable food the carbon is appropriated to give warmth to the system by its combustion therein, and it, with the vapor of water, is returned to the air again, in the products of this combustion, to be appropriated by new plants in their growth; while the other matters are, or should be, returned to the earth to supply those mineral and nitrogenous matters which they contain to the growing vegetation, and without which the latter cannot grow or develop. And this holds equally true whether the animal eats vegetable or animal food; for, where the former is true, the animal only consumes the animal which eats the



THE ODORLESS EXCAVATING APPARATUS.

Fig. 2



vegetable, even if through several successive consumptions of animal by animal.

In this view it is self-evident that the only proper disposition of the matters which are rejected from the human body, as with that of all other animals, is that they shall be returned to the earth whence they came; and any other disposition of them must be, aside from all considerations of health, contrary to natural economy. But the obvious detriment to health and danger to human kind, coming from the pollution of rivers whence water for sumptuary purposes may be obtained, and the dire effects of the contamination of the air of cities and houses by the deadly gases emanating from the liquid and solid contents of sewers and connecting conduits, which is known to obtain even under the most perfect system of sewerage yet devised, is sufficient to make this one of the growing and crying questions of the day. The insidious subtlety of sewer gases, too, is the more dangerous from the fact that they do not manifest themselves to the senses in any considerable degree; and although they possess a peculiar, though quite indistinct, odor, their presence is not readily discoverable by means of it, except to persons somewhat expert in such matters; and their deadly work may be in full progress in a house or in the air of a city without suspicion on the part of the inhabitants. It seems now to be pretty well admitted at all hands that most diseases which assume an epidemic form, and febrile and typhoid diseases generally, owe their origin to living germs contained in the air, the poison entering the blood through the lungs; and it seems to be equally well shown that these germs have an extraordinary faculty of reproduction. With this view, and knowing, as we do, that it is practically impossible to so construct traps or other devices, either in the house or street, which shall, while they admit the refuse matter, perfectly retain and prevent from passing out of the pipes and passages leading to the sewers these deleterious gases; and so long as it is possible for a single germ to make its exit from the sewer into the house or street, there is no knowing where its influence is going to stop, or how soon it may commence to reproduce its kind, and sow disease and death wherever its influence, or that of its progeny, may extend.

Before it became the practice to connect the commodes of houses with the street sewers, which is now so much resorted to, no such deadly influence could be attributed to the gases which might arise from their contents, which then consisted merely of the refuse and washings of the streets; but with the system now in vogue not only is the fæcal matter from healthy persons permitted in immense quantities to flow through them, but also that from persons suffering from diseases of all kinds, of many of which nothing is more certainly established than that they are conveyed and propagated through this *rejecta*, and the emanations from it. In view of such facts, it is not to be denied that some escape from the present system of disposing of these matters through the sewers of a city is becoming one of the indispensable conditions of existence in large and densely populated communities.

The great increase of typhoid complications in lung diseases, and the development of that modern scourge diphtheria, is now well understood to be largely attributable to the sewer systems used in most large cities, and are believed to proceed from germs which originate in these underground conduits. The most perfectly devised traps and methods of confining the sewer gases to the sewers and pipes fail to prevent the passage into the air of these germs, even where the gases themselves are perfectly retained within them, from the fact that all such devices depend upon a comparatively small body of water as the bar to their issue; water being incapable of preventing the escape of the germs even if the gases themselves are effectually confined to the pipes, which in itself may be doubted. It is more than probable that the water in a trap is competent to dissolve considerable volumes of these gases, become saturated therewith, and give them off again at the surfaces exposed to the rooms and sewer openings, wherever it may lie quiescent in them for a considerable time; while so great is the vitality of the disease germs contained in them that even considerably high temperatures, such as are fatal to living organisms generally, fail to destroy them, and the water allowed to rest in sewer traps is but an ineffectual barrier to their passage from the pipes to the air of houses and streets, inasmuch as the germ life is not destroyed by it.

At first thought it might seem a retrogression to advocate a return to the use of wells and sinks located near dwellings in which to deposit these substances, and as a mere question of convenience, to which we are all willing to sacrifice so much in these days, such is in some degree true. But, aside from this last consideration, it is by no means certain, both as it affects our pockets and the health of our bodies, that an immediate change from the sewer system back to the old sink or well would not be an improvement.

Before the advent of the present methods of emptying and disposing of the contents of these sinks their use was deleterious—dangerous to life, indeed—costly, and in every way objectionable; and this was more particularly true before the present systems of supplying cities with water were in use, and the principal supplies of that liquid were obtained from similar wells, filled by the natural drainage from the surrounding earth, and often placed in quite close proximity to the privy wells. In such cases nothing could be more objectionable in a hygienic point of view then the use of these sinks, and a great many well authenticated cases have been known where the one drained directly into the other, thus contaminating every drop of water used by the occupants of premises where these conditions existed.

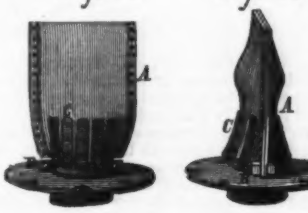
The emptying of them, too, was a most disgusting and health destroying operation, and expensive beyond any plan ever resorted to. Necessarily performed in the night, men could only be had to do such duty, and at such hours, at high wages; houses were exposed to depredation, and the whole premises disgustingly soiled in the operation, so that the coming of one of these bands of midnight workers was regarded as such an unmixed evil that their services were always dispensed with until the necessities of the case rendered their employment imperative. But here the evil did not end; their noisome loads were removed from the premises and drawn for miles through the streets of the cities, offending the senses of all who might perchance be about at such hours, and in the warmer seasons treating the oblivious sleeper along its route to a repast he little dreamed of, and it was then, as now, through the sewers, thrown into the rivers, to accumulate, by its superior specific gravity, about the particular pier heads used for this purpose, to be a continual source of danger and offence; and the entire cost of the operation was a clear outgo, without as much as a cent of value returned in any way from this immense amount of intrinsically, and, when properly disposed, really valuable material.

It might be objected that the mere existence of a well or sink upon a premises, and used for such purposes, would be deleterious through the emanations from its surface; but if this be the only objection to their use, it may be shown that, with the many cheap disinfecting and deodorizing chemicals to be had in these days, that to render them innocuous, and keep them so, by a periodic application of small quantities of these chemicals to them, would be an easy way out of that dilemma. At worst, the emanations from the surfaces of these sinks have the form of hydrogen sulphide and ammonia, and the worst that can be said of these gases, and particularly of the last mentioned, is that they are offensive. The first mentioned substance is, however, produced in such small proportion as to render the latter almost exclusively that which is recognized through the nostrils in such places; and not only is ammonia in the quantities met in out-houses of this kind free from any unhealthy tendency, but it exer

cises a positively wholesome influence, and acts largely as a disinfectant toward the other emanations. Sinks and cesspools of this kind become objectionable and dangerous only when substances other than urine and fæcal matters from healthy persons are permitted to flow into them, when they, no doubt, become productive of disease germs similar to those emanating from the sewers; as they then become, by the admixture of substances which otherwise would reach the gutters, and finally the sewers, and which are by themselves innocuous, masses similar to that which is now found so dangerous to health in the sewers themselves. So far as the deprivation of these deposits of their odors is concerned, it may be said that, if a tithe of the expense and trouble were expended upon them with this view that is nowadays lavished upon the modern watercloset, they might be made as comfortable, convenient, and unobjectionable in every way as the best of them; and that while they may be so readily discharged of their contents, and in a manner so entirely unobjectionable as is done under the system shown in the illustrations, there can be no necessity of their ever becoming offensive or dangerous.

Whether we ever succeed in finding anything better than the use of vaults and sinks as receptacles of these matters or not, it requires no prophetic gift to demonstrate that the present system of using the sewers for such a purpose must be done away with, or materially modified in some way that will render it less dangerous to the public health. In those smaller cities and towns where the sewer system has not been resorted to, the method of disposing of these matters, now practised by the Company whose apparatus is shown in the

Fig. 3. Fig. 4.

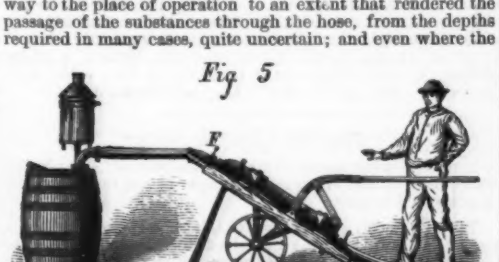


figures, is as nearly perfect as we can ever expect to see carried out.

The discharging of the contents of privy vaults during the hours of daylight, and without offence or danger to health, as well as the utilization of the matters taken from them for fertilizing purposes, has been a problem long and slow of solution, and, as with most important improvements of a mechanical nature, much cultivation and many patent right lawsuits have grown out of it. Time, the great healer, however, finally ends these feuds and puts the public in possession of the coveted improvements, purified and cleared of their entanglements by the smoke of battle.

Without referring to the litigation which has resulted in sustaining before the U. S. Courts the most important of the patents held by the Odorless Excavating Apparatus Co., the history of the system in use by it is an interesting one. Many years ago the removal of night soil in airtight receptacles was suggested, the idea then being that of exhausting the air from a vessel, sufficiently strong to resist the extreme pressure of the atmosphere, connecting this vessel by means of suction hose with the contents of the vault, which latter were intended to be forced into the exhausted tank by the atmospheric pressure. The formation of the partial vacuum in the receptacle was brought about in several ways: by filling it with steam which, upon becoming condensed, left a tolerably complete vacuum; by exhausting with air pumps driven by the wheels of the truck upon which it was transported, or by similar means before starting for the premises to be cleansed; or, by filling with water which was discharged through a pipe descending through a greater column than that due to the pressure of the atmosphere. The trouble, however, was not so much with the processes of exhaustion as in the subsequent removal of the contents of the vaults by means of it. In the first place, the vacuum found could not be sufficiently perfect to insure that the full pressure of the air could be availed of for the forcing of the semi-liquid matters into the receptacle, or the vacuum became vitiated on its way to the place of operation to an extent that rendered the passage of the substances through the hose, from the depths required in many cases, quite uncertain; and even where the

Fig 5



THE BARREL SYSTEM.

exhaustion was comparatively perfect, the volatility of the ammoniacal and other gases, which arose within the receptacle and hose from the newly disturbed matters from the vault, soon supplied sufficient pressure within the tank to so far enfeeble the force available for the propulsion of the matters through the hose that they would fail to rise into it.

From these considerations it soon became apparent that some method must be employed which could utilize the full weight of the atmosphere in lifting the substances the required height, be adjustable to varying depths of sink, and be competent to force the substances into the receptacle against such considerable resistance as was found to arise from obstructions of a nature foreign to the legitimate contents of such places, and which are more or less invariably to be found in them. To doctors, however, two very knotty problems presented themselves for solution: one that the offensive odors, if not unwholesome emanations, from the disturbed contents of the vault must be permitted to escape from the receptacle as it became filled with the solids and liquids of the vault, and mingle with the external air only when deprived of their objectionable qualities; and the other, that some kind of lifting and forcing pump must be devised that would permit of the free passage through it of any obstructions of a solid nature which might enter the opening at the bottom of the suction pipe. The first of these two necessities of the case was completely satisfied in the apparatus for which a patent was granted to Louis Straus in 1868, consisting of the combination of an airtight tank, a forcing pump, and a deodorizer, the latter being really the only successful part of what was new in the combination, the pump failing to meet the requirements of the case.

In 1873, William Painter, of Baltimore, invented and patented the valve shown in figures 3 and 4, designed to permit the passage of any obstructions which could enter the suction orifice, and to act as a tight valve, even when such an obstruction should become lodged within the valve itself, as is shown in fig. 4. It is well described in the inventor's own words as follows. Referring to figs. 3 and 4, he says: "It is made of soft, elastic, vulcanized rubber, A, tubular in form, and being composed of two flat pieces placed face to face and fastened together at their edges, is, in its normal condition, collapsed. Its length is equal to some three diameters when open. One end is distended, and, embracing a collar, B, that surrounds the port, is securely fastened thereto by clamps and bolts. Straps or plates, C, are arranged at the base of the valve to directly guard the port and prevent it from being forced into the port by external pressure. Similar plates on the inside of the valve protect it from puncture and abrasion. The valve is therefore, essentially, a collapsible tube, one end of which is permanently distended to embrace the port through which the material passes. The passage of material in one direction through the valve is direct and unresisted, while it cannot take place in the opposite direction, by reason of the collapse of the valve by the pressure on its sides. The valve, being of much greater length than diameter, presents an extended bearing or contact surface between its two sides, which closely engage and surround whatever obstruction may be passing through it at the time of its collapse, forming about the obstruction an airtight joint, as shown in fig. 4. At the succeeding stroke of the pump the valve is again distended, and the obstruction passes forward without in the least interfering with the action of the pump."

The production of this valve was the one thing required to complete the forcing system; the deodorizer of Straus performing its functions in a perfect manner. It consists simply of a small charcoal fire kept burning at the orifice through which the offensive odors must otherwise escape from the tank, the gases being obliged to pass through this fire upon their way into the atmosphere, which is found to completely destroy all odor, and must be equally sure to deprive the gases of any deleterious properties they might possess.

The pump is a very simple single-acting one, so arranged as to make a continuous reception and discharge of the matters in a direct line through it, and so effective is it for the purpose designed that it freely permits the passage through it of any conceivable kind of material which might enter it, as stones, sticks, shavings, rags, ropes, bottles, bones, and what not; and in known cases an entire pair of heavy cloth pants and a full sized army blanket have been pumped through it easily; and perhaps one of the most remarkable tests to which it has been put is that of pumping through it some fifty feet of a large sized rope, passing at the same time in a perfect manner liquids or semi-liquid substances. The construction of the pump will be readily understood from the engraving, fig. 2, and the larger figure illustrates equally well the application and operation of the entire apparatus.

The removal of night soil in airtight receptacles is not confined to the use of a large tank on wheels, as shown in fig. 1; it is similarly forced into barrels of ordinary dimensions, in which form it becomes, when sealed, a merchantable package, and is in form for handling and transportation to a distance with great facility.

A number of patents are in existence for improvements, both in the "forcing" and "vacuum" systems, the principal ones, some 20 in number, being controlled by this Company.

The Company has an excellently arranged plan for discharging the contents of the large tanks into airtight barges or car tanks, just as is done in the transportation of coal oil; and in the transfer of the material to either of these the same deodorizing apparatus is employed as that already described.

Fig. 5 shows the apparatus as used in the "barrel" system. To complete this system and render it applicable to the most extreme cases, as to difficulty of removal of the material, the plan shown in fig. 6, and called the "pitting" apparatus, is resorted to, and consists simply in covering the approaches to an outhouse with a kind of canvas awning, from which is led a flexible tube to the deodorizer, to destroy the effects of the gases and odors generated in the disturbance of the material inside. The awning likewise excludes the operation from observation. This plan is only resorted to in cases where the contents of the vault has become from long standing or other causes so unyielding as to preclude the use of the pump, in which case it is simply removed by digging, which, in its comparatively solid condition, is not by any means so disagreeable an operation to the workmen inside the awning, as was the old bucket system with the more liquid contents. In this way it is removed in the daytime without offence to either sight or smell. It is rarely necessary to resort to this plan, but it becomes a necessary adjunct to the completion of the system adopted by this Company.

The pumping and "pitting" apparatus constitute a complete system for cleaning sewer traps and basins without offence to sight or smell, avoiding the obnoxious features of an operation incident to all cities where sewers are used. In this case a specially constructed awning is employed, covering the mouth of the sewer and concealing the entire operation, while the noxious gases are drawn off and consumed as already described. This system is now largely in use and is fast becoming extended throughout the country.

With the tanks and apparatus kept in a cleanly and sightly condition, as they pass in view of pedestrians and residents upon the route, there is no offence even to the most fastidious; and certainly the nicely painted tanks and trucks which are daily seen perambulating the streets of Philadelphia and other large cities are as unobjectionable in every respect as an ordinary watering cart.

The entire apparatus was on exhibition at the Centennial in the Hydraulic Section of Machinery Hall, and received much attention from people interested, and an award, based upon the following report, was made them. The judges in their report say:

"The undersigned, having examined the Apparatus herein described, respectfully recommend the same to The United States Centennial Commission for Award, for the following reasons, viz.:

1. "Superior efficiency—the Pump and Valve being of entirely novel construction, which enables the refuse usually found in sinks to pass through without clogging.

2. "Economy—the work being accomplished in the daytime, with far greater facility than by the old method.

3. "The great sanitary advantages it presents—the operation being effected without the least odor or offence, the air being thus relieved of noxious or poisonous gases.

4. "It being the original Apparatus used in this country, and having inaugurated a reform in the removal of night soil from privy vaults, etc., the sanitary advantages of which cannot be over estimated."

(Signed), CHRIS. C. COX, M.D.,
C. B. WHITE, M.D.,
AZEL AMES, JR., M.D.,
Judges.

The success which this system has met with in the past three or four years shows pretty conclusively that in it is a practical solution of the difficulties which have so long beset this important question. J. T. H.

FIG. 6.—THE PITTING APPARATUS.

THE FLASH LIGHT.

THE "Flash Light," or safety signal, is a practical preventive of rear collisions, and on divisions of road fully equipped with it such collisions are almost unknown. About one hundred caboose cars are now running with it, making an aggregate of thousands of trips run since this light was attached, without an instance of collision. It is a great assistance in moving trains promptly and safely, and there is no more excuse for allowing two trains or detached parts to come in collision by night than by day, as the flash of the white light shows in both directions the position and speed of the train. It is a great improvement over common lights for fogs or storms, because the flash of the white light can be seen at a greater distance. For instance, if a train of forty cars be approaching with two of the common red lights on the front of the engine, the spectator, if a little to the right, will see the white flash of the caboose light a considerable time before the red lights (a train length nearer to him) are visible. This feature is an additional indication of distance which no other light has, and engineers practice following it at such distance that the red lights are dim or out of sight, and can then judge of the speed of the leading train by the flash of the white light, as well as though the side-rods of the engine could be seen. It is simple and durable, and the cost for a line or division of road is so light, that it may be saved by the prevention of a single accident. The inventor is Mr. Wm. C. Needham, of Cleveland, O.—*Chicago Railway Review.*

A CABLE GRAPNEL.

AT a recent meeting of the British Society of Telegraph Engineers, a new form of cable grapnel was exhibited by the Western and Brazilian Telegraph Company, and explained by Mr. A. Jamieson. Cable lifting being an operation moved far beyond the sphere of ordinary observation, most people are ignorant of the peculiar difficulties by which it is surrounded. Of these, the breaking of grapnels is one of the most frequent and serious, and Mr. Jamieson's invention is designed to overcome this difficulty. The ordinary grapnel is furnished with rigid prongs, which, although perfectly well calculated to seize and bring the cable to the surface, are also liable to become fastened to rocks and other substances, and to break with the slightest strain of the ship. Of such frequent occurrence is this, indeed, that all cable ships are compelled to carry a very large stock of grapnels on board, and have often to return to port without accomplishing their task, owing to loss and breakage. Mr. Jamieson has furnished his grapnel with hinged prongs, governed by a spring, which yields at a given strain, so that the moment a rock is "hooked" the grapnel slides off and comes to the surface. It is, in fact, an octopus-like machine, which puts forth its "feelers" in search of the real article, and draws them back the moment any counterfeit substance seeks to entangle them.

FRICTION OF PLAIN SLIDE VALVES.

By JOHN W. HILL, M.E.

SEVERAL months ago, the writer, in the routine of duty as a contributor to a Western mechanical journal, furnished for publication an article under the above head. The paper had for its purpose an exposition of the true relative power expended in moving the ordinary slide valve of steam engines, with such hints upon the construction as would aid designers in reducing the loss of power by friction of the valve to a minimum. Since its original publication, the article has been reproduced in other papers, and variously commented upon. The vigor and pertinacity with which the writer's conclusions upon this topic have been disputed, by certain parties in interest, induces the present paper, which, it is hoped, will place the matter in such a clear light as to remove all doubt upon the accuracy of the results deduced.

As an index to the present investigation, it should be understood that for several years past a class of semi-mechanics have been peddling about the country various kinds of balanced slide valves, some of which are ingenious in construction, whilst the majority fail to command even casual attention, and all are worthless when placed squarely upon their merits, as their purpose is to substitute for an insignificant evil a greater though less obvious one. Owners of steam engines have been surfeited with circulars and testimonials commending the various traps; and after the benefits of the circular system have been completely exhausted, the inventor himself usually commences his pilgrimage. In due time he opens an assault upon some luckless owner of a steam engine, by explaining in technical terms the many virtues of his improved valve, and the utter lack of these desirable qualities in all valves hitherto in use. There are few owners of engines who can successfully resist the seductive charms of the "new valve," and in due time the owner consents to have his otherwise good engine "improved" by the industrious semi-mechanical missionary.

The projectors of these improved valves are rarely modest men. Those, however, having a regard for the remote future, limit their claims of saving in cost of the power to be effected by the use of *their* valve at from 15 to 25 per centum, whilst others with a more elastic conscience usually estimate the benefits to be derived from "*their*" valves at from 25 to 50 per centum. Obviously, the only saving that a relieved valve can effect, as compared with an unrelieved valve, is the power expended in moving the latter. Conversely, there is not a single relieved valve in use, so far as the writer is aware, that has not, in a very short time after introduction, become so leaky as to render it a nuisance in the enormous quantity of steam passed into the exhaust, without performing its office in the cylinder, the steam thus wasted entirely obliterating any beneficial effect that might be obtained from a reduced load on the valve. Railway master mechanics who have investigated the relative merits of relieved and unrelieved valves generally agree that the wear of links and joints of valve gears is least with relieved valves. Upon the other hand, they quite as unanimously agree that the relieved valves soon become excessively wasteful of steam, and that no increased economy of performance is perceptible in their use. Upon the whole, the experience of railway mechanics appears to decide the relieved valve as inferior to the plain slide valve (*vide* Rep. M. M. Convention 1874).

The purpose of this article, however, is not in disparagement of relieved valves, but rather to show that such valves are the result of an imperfect knowledge of the friction of the unrelieved valve in its simplest form. That this imperfect conception of the true relative power expended in moving the valve is not confined to obscure persons is evidenced by an article in the SCIENTIFIC AMERICAN under date of September 30th, 1876, in which the editor says: "If we consider the valve of an ordinary 16-inch cylinder engine to measure 8·5 by 14 inches, and allow a pressure of 130 pounds per inch in the steam chest, there would be, supposing the valve to bed perfectly on its seat, a pressure of $8{\cdot}5\times14\times130=15{,}470$ pounds forcing the valve to its seat; and the whole pressure upon the piston being 26,442 pounds, the friction of the valve would entail a loss of $\frac{15{,}470}{26{,}442}=58$ per centum of the power of the engine."

The quotation contains two erroneous assumptions: first, that the friction is a measure of the area of the valve into the pressure per square inch independent of well-known co-efficients of frictional contact; and second, that the travel of valve is equal to the stroke of piston. Taking the data of the editor and allowing 20 per centum as the co-efficient of friction for cast iron on cast iron, and the travel of valve as ·2 of the stroke of piston, then the power absorbed by friction of the valve becomes $58\times{\cdot}20\times{\cdot}2=2{\cdot}32$ per centum of the power of the engine, instead of 58, as estimated by the editor.

The general treatment of the "power absorbed by friction of the ordinary slide valve," in the accepted text-books on the steam-engine, is vogue and in nowise calculated to convey to the mind of the student the exact *status* of the problem. Rankine observes that "the slide valve is pressed to its seat, and the joint between it and its seat kept steam-tight by the excess of the pressure of the steam in the valve-chest, behind the valve, which comes from the boiler, above the pressure of steam in the interior of the valve, which communicates with the condenser or atmosphere. The amount of pressure of the valve against its seat due to the pressure from behind is the product of the intensity of that pressure into the area of the face of the valve." Again, he says that "in the cases of large valves the load of resistance is unnecessarily great."

It is an undeniable fact that, as the area of valve increases, the actual power required to move it increases; and in the case of large engines, provided with slide valves, the force required to move them may be so great as to make it desirable that they be relieved, so as to allow ready manipulation in reversing and shifting the link, or other variable expansion gear; but if this convenience of handling, and reduced expenditure of power in moving the valve, is obtained with a sacrifice of economy in the performance of the engine, the question presents itself whether it is not preferable to use the slide-valve in its simpler form, with the corresponding economical performance, than to substitute relieved valves wherein the loss of steam between the valve-face and its seat, into the exhaust, more than compensates for the increased facility of manipulation.

The writer is unaware of any experiments being reported, except by parties in interest, upon the relative economy of the different systems of slide valve; but from such data as he has been able to collect, he is of the opinion that the highest grade of economy is to be obtained from engines with the plain valve.

Evidently the expenditure of power in moving the ordinary slide valve is the moment of friction into the travel, and the moment of friction is a function of the surface in contact and the unbalanced load on the steam side of valve (the total load being the area of the back of valve, parallel to the plane of motion, into the pressure in the chest). From this it appears incidentally that the smaller the valve for a given effect, the less the power absorbed in moving it. An erroneous idea prevails among engine builders that the friction of the valve is entirely independent of its size, and only dependent upon the area of steam passages which it covers. The fallacy of this conception will be evident in the following demonstration:

Let A represent the area of valve parallel to face impinged upon by the steam in the chest, and P the intensity of pressure in the chest. Assuming A as a constant for all positions of valve, then the total load upon the valve perpendicular to the plane of motion becomes $A\times P$; and were it not that a portion of this quantity is neutralized in its effect by a force also acting in a plane perpendicular to the motion of valve, and diametrically opposite to the force AP, then this latter, modified by a proper co-efficient, would represent the moment of friction at all points in the travel.

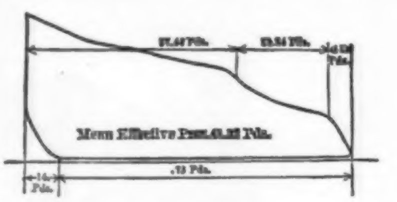
Let A′ represent the effective area of under side of valve referred to, complete stroke of piston, and P′ the corresponding mean pressure, then $A'\times P'$ is the neutralizing force; hence the moment of friction, F, is a function of $AP-A'P'$. Let B represent the travel of valve in feet; then the expenditure of power in overcoming the resistance of friction in the valve is expressed by the equation—

$$H=\frac{F\times B\times 2r}{33{,}000} \qquad (1)$$

Let H′ represent the indicated horse-power of engine, then the per centum of power, K, thus expended, becomes—

$$K=\frac{H}{H'}100 \qquad (2)$$

To exemplify the foregoing principles the writer assumes an engine of 16-inch cylinder, 400 feet speed of piston; slide valve 8¾ by 14 inches; travel 5 inches; steam ports 15 square inches area; exhaust port 24 square inches area; pressure in the chest 85 pounds; steam cut-off at two-thirds piston stroke. The diagram is from an engine of these dimensions, and has been carefully estimated for this demonstration:



The area of valve parallel to the plane of motion is $8{\cdot}75\times14=122{\cdot}5$ square inches, pressure in the chest 85 pounds, and the total load $122{\cdot}5\times85=10{,}412$ pounds; the counter-pressure acting upon the opposite side of the valve is made up of the mean pressure from admission to cut-off, acting upon an area equal to the area of steam port, for half travel of the valve in opening and closing port, hence

$$\frac{15\times57{\cdot}44\times1{\cdot}25}{5}=215{\cdot}4 \text{ pounds.}$$

The mean pressure from cut-off to release, acting upon an area equal to the area of steam port, for whole travel of valve during expansion,

$$\frac{15\times31{\cdot}84\times1{\cdot}25}{5}=119{\cdot}4 \text{ pounds.}$$

The mean pressure from release to end of stroke, acting upon an area equal to the area of steam port, for half travel of valve during release,

$$\frac{15\times15\times{\cdot}625}{5}=28{\cdot}125 \text{ pounds.}$$

The mean counter-pressure from commencement of return stroke to exhaust closure acting upon an area equal to the area of exhaust pocket in valve, area of exhaust, pocket $12\times3{\cdot}75=45$ square inches, hence $45\times{\cdot}75\times{\cdot}9=30{\cdot}375$ pounds.

The mean cushion pressure from exhaust closure to opening of steam port at commencement of new stroke, acting upon, and equal to, the area of steam port for whole travel during compression,

$$\frac{15\times14\times1{\cdot}25}{5}=52{\cdot}5 \text{ pounds.}$$

In addition to this is the value of the mean pressure from release to end of stroke, acting upon the area of exhaust pocket, and the counter-pressure during the latter part of return stroke, acting upon an area equal to the area of steam port for half travel of valve during exhaust closure, lacking the data necessary to estimate their values, these elements are omitted. Taking these several quantities together, the neutralizing force becomes 445·8 pounds, then $10{,}412-445{\cdot}8=9966{\cdot}2$ pounds.

Assuming the co-efficient of friction in this case to have been ·15, then $9966{\cdot}2\times{\cdot}15=1494{\cdot}93$ the moment of friction, the double travel of valve ·83 feet, and the revolutions per minute 100, then

$$\frac{1494{\cdot}93\times{\cdot}83\times100}{33{,}000}=3{\cdot}76 \text{ H. P.}$$

The mean effective pressure by the diagram is 45·33 pounds; area of piston, 201; piston speed, 400; and the indicated power of engine becomes

$$\frac{201\times45{\cdot}33\times400}{33{,}000}=110{\cdot}5 \text{ H. P.}$$

and the per centum of power expended in moving the valve

$$\frac{3{\cdot}76}{110{\cdot}5}\times100=3{\cdot}4.$$

The opinion entertained by certain engineers that the slide valve floats on a thin film of steam between it and its seat, is not only untenable, but undesirable, for if the fit of the valve to its seat is such as to allow a circulation of steam of maximum pressure sufficient to balance the load (in part) upon the opposite side of the valve, it is likewise sufficient to permit the passage of steam between these surfaces into the exhaust. Again, considering the close relation that must necessarily subsist between the valve and the seat in order to *prevent* leakage into the exhaust, it is probable that the liquefaction of steam, due to the attraction of the metal surfaces, is sufficient to prevent the entrance of steam under the valve.

Hamilton, O.

CLEAVING ROCKS WITHOUT POWDER.

THIS invention is due to MM. Dubois and François, Seraing, whose rock-drill has done such good service in the works of the St. Gothard Tunnel.

The inventors contend that the driving of drifts by the aid of powder in fiery mines has always been the chief cause of explosions, and they believe that so long as powder or other explosives are employed, especially in galleries in the coal, these dreadful calamities will be perpetuated. To combat the idea that the use of explosive agents is indispensable, and that the working of a colliery would become difficult, if not impossible, without their use, MM. Dubois and François have set themselves the problem of driving galleries economically without the use of powder; and trials which they have made at the Marihaye Colliery have satisfied them that the solution is possible. With their machines the driving of coal drifts has proceeded with rapidity, probably with economy, and certainly with the greatest safety.

The machine with which the trials were conducted was entered in Class VI. (Belgium) at the Brussels Exhibition, and was awarded a silver medal. It consists of a large-sized rock-drill, mounted on a carriage, the principal portion of which is a cast-iron chest serving as an air reservoir. This rock-drill moves along on a screw of large diameter, and is capable, owing to an arrangement borrowed from steam-cranes, of being manœuvred so as to bore perpendicular or oblique holes, in the roof or sides of the gallery, to the right or left, and of a diameter of 8 to 10 centimetres (3 inches to 4 inches) or even more.

The first hole bored the full length of the travel, or feed ing power, of the drill (about 70 centimetres = 27 inches) in the portion of rock to be operated upon, constitutes the first operation, as it offers the least resistance. The chisel is then taken out of its holder and replaced by a mass of iron weighing from 30 to 40 kilogrammes (66 lbs. to 88 lbs.), keyed on to the holder in the same manner as is the chisel. After the introduction of a needle-wedge into the prepared hole, the machine, not having changed its position, and armed with the mass of iron, acts on the wedge like a hammer, and with repeated blows causes the rock to cleave.

The following examples will serve to show the rapidity, as well as the facility with which the work is carried on: In the driving of a gallery in a seam 30 centimetres (about 1 foot) thick, in very hard measures (graywacke, with bands of sandstone), which served for the first trials, the boring of a hole 70 centimetres (27 inches) deep, and from 8 to 10 centimetres (3 inches to 4 inches) in diameter, occupied, including the placing of the chisel, fifteen minutes; and the introduction and driving of the needle-wedge, ten minutes; that is to say, twenty-five minutes was the time required by a complete operation. This is equivalent, as far as the work and the result in bringing away the rock are concerned, to an ordinary shot-hole, 70 centimetres (27 inches) long, but without being attended with its dangers and its numerous disadvantages.

The following are the principal dimensions and data of the machine:

Diameter of piston, 0·11 metre = 4·3 inches.

Diameter of piston rod, 0·085 metre = 3·3 inches.

Weight of portion striking the wedge, 120 kilogrammes = 2 cwt. 1 qr. 12 lbs.

With air compressed to three atmospheres, the percussive force of the blow will be 300 kilogrammes = 5 cwt. 3 qrs. 17 lbs.

Total weight of machine, 1,700 kilogrammes = 1 ton 13 cwt. 1 qr.—*Colliery Guardian.*

DECLINE OF ENGLISH STEAM ENGINES.

THE decline in the export of steam engines from England is quite conspicuous. For example, the aggregate value of exported engines in 1876 was £1,937,579; in 1875, it was £2,631,333; but in 1874 it reached £3,255,685. Nearly all the countries which had heretofore been customers for English-made steam engines seem last year to have diminished their orders. Russia, which in 1875 paid the English manufacturers £333,319, came down in 1876 to £147,886; Germany fell from £233,033 to £89,182; British India from £436,459 to £247,908; and Italy from £170,688 to £151,319. In respect of France, Spain, Egypt, and the Brazils, a slight difference on the other side of the ledger is observable; but, as we have said, the whole tendency is downward.

THE ROLLING OF SHIPS.

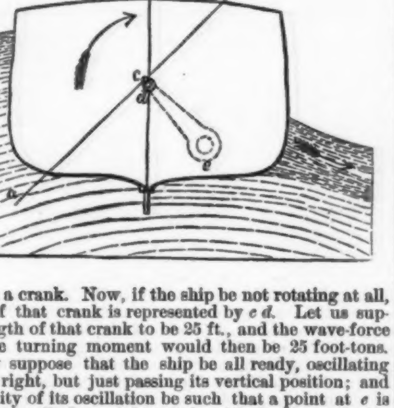
THE following paper, "On the Rolling of Ships," was lately read by Mr. William McNaught before the Society of Engineers, London:

There is hardly one subject at this time of greater importance, not only to those interested in shipping but to the nation at large, than a knowledge of the conditions of the rolling of ships; it is only those who have had some experience who can conceive the immense benefit that would be realized could we prevent or considerably diminish such rolling. We hear of ships losing their masts—often without considering that that means men pitched into the sea, and others killed by falling spars and rigging, besides the ship being reduced to utter helplessness, all by the excessive stress caused by rolling; also without considering that the very same strain or stress which has carried away the masts may at the same time so have strained the hull as to induce leakiness, or the strain may induce leakiness without the loss of masts; then there is the damage and loss of cargo, and many other things that might be enumerated that bear upon the importance of the subject. And yet, so far as the experience of the writer goes, there is not one subject in which shipowners, builders, etc., appear to be more apathetic. There are, no doubt, various causes for this; familiarity breeds contempt, even to danger, even to ourselves or others. Then there is the effect of insurance; but most of all, in our opinion, is incredulity of there being any practical method of really mitigating the evil. Indeed, some good thinking men look upon the idea as a chimera; they appear to be impressed with a conviction that the apparently sudden and violent lurches, which occasionally happen to such a vast mass as a ship, argue such a magnitude and variety of external force acting upon it as to be irresistible. This is a natural impression, and also correct to a certain extent. We cannot prevent a ship from being heavily drifted sideways when struck by a beam sea; neither can we prevent a ship from being lifted or lowered vertically; or both these motions may occur at once;

but rotating or rocking around the center of gravity of a ship is a very different matter. The two former motions may be impressed, and frequently are impressed, on a ship without communicating the rocking motion: this happens when the resultant of the whole external wave-force passes through the center of gravity or near to it. When this happens, no imaginable wave-force would produce rotation or rolling. Now, although we do not know the magnitude of that force, we know its direction. In that wave-force statical pressure and *vis viva*, or dynamical effect, appear to be so inextricably mixed up together as to defy any quantitative investigation; but not so its direction. Its direction upon any portion of a ship's hull, upon which it either presses or impinges, is always at right angles to that part or particle of the area with which it is for the instant in contact, and we may find, by means of a simple geometrical construction, that the resultant is never very far from the center of gravity in a well formed ship; consequently, it possesses little leverage to turn the ship, sometimes none, and consequently a small counteracting force would prevent rotation. This counteracting force we can command in abundance. To counteract either the lifting or drifting of a ship we have no external medium to reach upon any more than has a balloon in the air; but we have an excellent medium to reach upon to prevent rotation, namely, the inertia of the water underneath the ship.

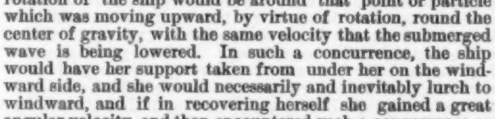
So much for the alleged impossibility of preventing rolling. We may nip it in the bud; and as to those heavy lurches, which produce on the mind such an impression of force, they arise from a concurrence of three motions, to go fully into which is not here necessary, but as it is an important subject, and one which ought to be more generally understood, we will briefly allude to the mechanical conditions. Fig. 1 represents the cross section of a ship struck by a sea, and consequently on the leeward side of the wave. The resultant of the horizontal and vertical forces is supposed, for the instant, to be represented by the line *a b*. We have on former occasions compared the resultant to a connecting rod

FIG. 1



acting upon a crank. Now, if the ship be not rotating at all, the length of that crank is represented by *c d*. Let us suppose the length of that crank to be 25 ft., and the wave-force 100 tons, the turning moment would then be 25 foot-tons. Let us now suppose that the ship be all ready, oscillating from left to right, but just passing its vertical position; and let the velocity of its oscillation be such that a point at *e* is moving horizontally from right to left, with the same velocity that the ship is drifting from left to right, and also that the same point is at the same time moving downwards as much as the ship is being lifted; then that point is at rest, both with respect to the center of the earth, and also with respect to any fixed point on its surface at right angles to the ship; consequently that point is for the instant the axis around which the ship is rotating, and the length of the crank will then measure from *c* to *e*, and if *e* be 10 ft. from the center of gravity of the ship the turning moment will be 1,025 foot-tons; and if it were not for the great moment of inertia possessed by a mass of matter in these circumstances, a ship would be upset. Indeed, there are other mechanical circumstances connected with these matters that seem equally providential; nevertheless, they have fatal occurrences which we may prevent. Let the circumstances be reversed, let the ship be rotating to windward, but at the same time its center of gravity being lowered, say, by the lowering of a submerged wave, which would of course cause a lowering both of superimposed wave and the ship; further, let the ship be on the windward side of the superimposed wave, then the absolute rotation of the ship would be around that point or particle which was moving upward, by virtue of rotation, round the center of gravity, with the same velocity that the submerged wave is being lowered. In such a concurrence, the ship would have her support taken from under her on the windward side, and she would necessarily and inevitably lurch to windward, and if in recovering herself she gained a great angular velocity, and then encountered such a concurrence as the first, the lurch to leeward would be fearful and such as to impress any one, uninitiated in the laws of dynamics, with an idea that it was futile to attempt to cope with such a

FIG. 2



force; and yet any one who has studied those laws knows well that no imaginable force could suddenly produce such an angular velocity without the dislocation and destruction of the whole framework of the ship. A force acting in the direction of the line *a b* on the diagram—adequate to induce such an angular velocity as we have often witnessed suddenly—would also project the ship out of the water. Such motions are always produced by degrees and by repeated impulses, and the object of our invention is to cope with those impulses at the beginning—and as they occur—and never permit them to impress any dangerous or even inconvenient amount of angular motion.

The author will now describe the apparatus shown in Fig. 2, and which consists of a balance rudder or vane at the end of a spindle; this rudder or vane can be lowered into the water underneath the ship through a slit in the ship's bottom, when required to be in action, or withdrawn into the ship when not required, or in shallow water; over this slit, and securely riveted or bolted to the bottom, is a strong receptacle, sufficiently strong to abundantly compensate for the weakness caused by the slit. This receptacle has a stuffing-box on the top, through which the spindle of the rudder passes. On the top of the spindle above the stuffing-box a lever is keyed for the purpose of turning the spindle round, and thereby causing the rudder to assume any angle with the fore and aft direction of the ship that may be required. *a* is the vane, *b* is the receptacle, and *c* is the lever. The receptacle may be placed on any part of the ship's bottom on or about the line of the keel, or there may be one on each side of the keel, or one vane on each side of the ship outside without any receptacle; and, in order to prevent any interference with the steerage of the ship, it ought to be at about one-third of the length of the ship, measuring from the fore end.

The manner of its action is precisely the same as that of a rudder at the stern of a ship, viz., by the water impinging against the inclined surface of the vane. The position of the steering rudder is such as to turn the ship on its vertical axis if required, or to resist its being turned out of the straight line; but the position of the steadying rudder, being underneath the ship, is such as to turn the ship on its lengthway horizontal axis, or to resist its being so turned out of the perpendicular.

We now come to the origin of rolling, the most eminent authorities on which are Dr. Woolley and Mr. Froude; the former, as far as I understand, attributes the initial and continuous forces to *vis viva*, or the effect of waves striking a ship; the latter to the effect of statical pressure acting normally to the surface of the water, be it inclined or horizontal; in both hypotheses there is one condition assumed which cannot be controverted, viz., that the said forces, whatever may be their nature, must be repeated, and the period of each repetition must concur with the period of oscillation of the ship, considered as a species of inverted pendulum. We imagine that it is a species of *kinetic energy*. If we imagine a stream of bullets striking a target—such as forty years ago might have been witnessed from Perkins' steam gun—we may imagine that the effect upon that target would very much resemble statical pressure while the steam lasted. Or we may imagine a chain suspended from a considerable height and let fall—the effect upon the ground struck by each successive link would very much resemble statical pressure. In both these cases the force is kinetic energy or sustained *vis viva*. If a ship were floating in perfectly still water, it is possible for a force of this kind to traverse from one side to the other underneath the bottom of a ship; the original of such a force may be motion of the water at an unknown distance from the ship, and conveyed by a diffusion of energy, without the surface of the water being sensibly affected. If such a kinetic wave were to repeatedly traverse the bottom of a ship concurrent with the period of its oscillation, it would account for the phenomenon of a ship rolling in still water. We imagine also that when a ship is acted upon by a beam sea that it is a similar kind of energy, the intensity of which may be various on various parts of the length of a ship, in which case the action would be different from the action of statical pressure, which varies as the depth, whilst kinetic action may be as great at the surface of the water as below. So also would be the effect of *vis viva*, adopting Dr. Woolley's hypothesis, which also assumes kinetic action. To use the word "imagine" may look unscientific, but we agree entirely with Professor Tyndall, that it is solely by making excursions from some central standpoint, in various directions prompted by the "imagination," that we arrive at truth in most of the physical sciences. It is upon the above assumption that we affirmed in the first paragraph that the direction of the resultant, when a ship is struck by a beam sea, might be found by geometrical construction. We cannot, however, pursue that any further at present than to observe that the supposition also affects the theory of the curve of least resistance.

But, whatever may be the nature of the forces, it is generally agreed, first, that their resultant is continually shifting to opposite sides of the center of gravity of the ship. Secondly, that their initial turning moment is very small when a ship is not already oscillating, but increases with the amplitude of the oscillation. Thirdly, whereas that the condition of isochronous rolling is that the turning moment shall increase exactly as the amplitude of the roll increases, and which condition can never be fulfilled in any practicable form of ship; and whereas though the impulses from the sea are not isochronous for a lengthened period of time, they do not change so rapidly as does the period of roll in a ship from the above cause, *i.e.*, increase of amplitude. It follows that a time arrives when such impulses from the sea no longer concur to assist oscillation, but to oppose it, a most remarkable and, we may say, providential circumstance. The steadying rudder is intended to assist in such opposition. On a former occasion the author did not think it was necessary to attempt to go minutely into the details of the manipulation of the vane, thinking that a little practice and experience would soon develop the proper way—but the following are our ideas at the present time: There are instruments which we need not here describe—which would plainly indicate if a ship should only deviate half a degree to right or left from the perpendicular—and the attendant must be supposed to have one of these before him. His orders are precise, that is when the ship has inclined to the right, and is on the point of returning towards the left, he that instant pushes the handle which works the steadying rudder to the right, and thus diminishes the backward roll. If this should bring the ship to its vertical position without passing it, he would put the vane in its neutral position and wait; but if it passed the vertical position, he would, as before, when it got inclined to the left and was on the point of returning, instantly push the handle to the left, thus he would continually oppose the tendency to roll; all these motions must not be supposed—except occasionally from irregular impulses—to exceed half a degree. A false move, or, indeed, several, would not be of much consequence, for the power or area of the vane never needs to be so great as to be dangerous, it only needs to be able to counteract incipient rolling. We know, as stated above, that the resultant of the water pressure, be it statical, or *vis viva*, or kinetic, passes through the ship alternately on each side of its center of gravity at all distances within certain limits depending on the form of its cross section; consequently, the turning moment will vary between those limits. Now, if the area of the vane is such that its moment is equal to the mean moment of the water pressure, or slightly more, it would be sufficient to prevent that rolling from commencing, which ultimately causes *lurching*. This is a purely mechanical matter, the laws of which we presume are the same at sea as on land.

Now if we had a ship removed from the water, and mounted upon pivots coinciding with her center of gravity, we could calculate by the known laws of dynamics the force, or rather the moment, that would turn her over to any given angle in any given time, and by inverting the process turn her from any given angle back to her perpendicular. It is the same with oscillation of a floating body, for although the turning moment may be very great when a ship is forcibly held at any given angle, it is equally great in the opposite direction if we let it go; so that the result of those momenta is, as has been said on other occasions, $-o$, and we really have nothing to deal with to destroy any amount of roll already initiated, but the inertia of the matter in the ship and the amount of disturbance from its vertical position, or half the angle of roll.

The force upon a steadying rudder that would turn a ship round its center of gravity any given angle z in time t, may be found by the following formula, neglecting the viscosity and inertia of the water—

$$\frac{\begin{pmatrix}\text{Weight of ship}\\ \text{in tons.}\end{pmatrix} \times 24{\cdot}4 \times \begin{pmatrix}\text{radius of}\\ \text{gyration}\end{pmatrix}^3 \times Z}{\begin{pmatrix}\text{Distance in feet from center of}\\ \text{gravity to center of rudder}\end{pmatrix} \times t\,.} = \begin{matrix}\text{Force on}\\ \text{rudder}\\ \text{in pounds.}\end{matrix}$$

And this force during time t would communicate to its proper angular velocity to the ship, or, if required, destroy that amount of angular velocity at the will of the attendant.

The author is indebted to the Lords of the Admiralty for the following data relating to the Shah and the Devastation: The latter is an ironclad; the former not. Shah, weight 2,920 tons; radius of gyration, 24·7 ft.; radius to center of steadying rudder, 23 ft.; time of one double roll once across the arc and back again, 16·5 seconds. Devastation, weight, 9,166 tons; radius of gyration, 23·3 ft.; radius to center of rudder, 34 ft.; time of one double roll, 13·62 seconds. When these quantities are introduced, assuming the angle across the arc to be 4 deg. or $z = 2$, and the time of two double rolls being 33 and 27·24 seconds, the requisite force on the rudder or vane will be

Shah, 5,633 lbs.
Devastation, 9,655 lbs.

And assuming that the ships are making seven knots an hour, we estimate the force on the rudder at 280 lbs. per square foot. When the angle is about 20 degs. with the line of motion, this gives for the area of rudder respectively—Shah, 18·74 square feet; Devastation, 32·18 feet; and if two vanes or rudders were employed one on each side of the keel, their dimensions would be respectively 2 feet broad by 4·68 feet long, and 3 feet broad by 5·3 feet long each.

A ship of 800 tons weight of displacement similar in form to the Shah, would have 19·3 feet beam; and assuming the radius of of gyration to be 37 of the beam—as is that of the Devastation—or 7 feet, the time of one double roll would be 7·6 seconds, radius of rudder 9·25 feet, and under the above conditions the force on one rudder would require to be—"Anonyma," 669 lbs.; and employing two rudders, the area of each would require to be 1·16 feet, or 6 in. broad by 2·32 feet long. The name is used for reference.

But it is next to impossible for such ships to suddenly obtain 4 degs. of a roll. I believe that one degree might be easily perceived by the attendant with a proper spirit level, and really do not like to state what might be expected if the attendant were to put his rudder into action, as before described, when the ships were rolling 1 deg., or ½ deg. on each side of the vertical, that the requisite force on the vanes or rudders, as before described, would be reduced respectively to 1,405 lbs., 2,413 lbs., and 167 lbs. It looks incredible to the uninitiated in the laws of dynamics.

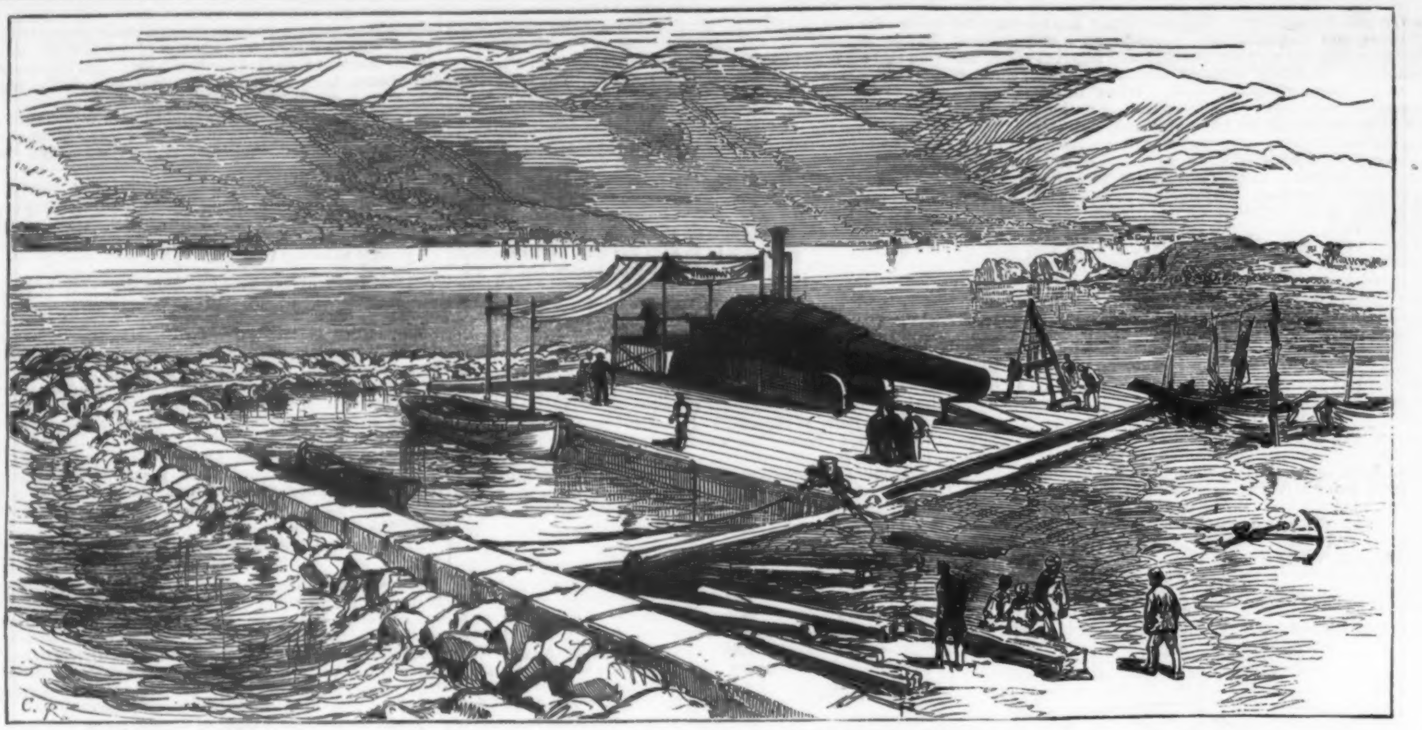
It nearly always happens, in carrying out any mechanical arrangement, that the realized effect is less than might have been expected from calculation; in other words, we seldom get practically so good a result as theory would lead us to expect. This is mostly occasioned by the friction and inertia of the parts of the machine and of the subject upon which it acts. But in this case it would appear as if the Divine Engineer had inverted the usual order of things. What usually hinders and obstructs, here comes to our assistance. Friction is represented by the viscosity of the water—there is its inertia as well—both of these have a tendency to destroy oscillation in a floating body. Then there is the inevitable clashing of the periods of oscillation of the ship and the waves, alluded to above, without which no ship could live many voyages. It may be said that these are general or desultory remarks, but they are strictly applicable to the case in hand. If a ship were floating in still water, and if water was devoid of viscosity or inertia, the time of turning it a given angle would be exactly that given by the formula; but owing to its viscosity and inertia, that time would be less. We do not know how much, but it would be less, not more, than by the formula. But what about rough water? A roll of 4 degs. could not be impressed upon a ship instantly. But even if it could, the roll could not be increased unless the impulses were repeated concurrent with the period of the ship's proper oscillation. But if it should be so, that period would be altered the instant the steadier was brought into action, and the change of period would be expressed by the formula which is given in a foot-note;* and then the action of the sea would assist the steadying rudder in destroying oscillation. We have said nothing about the moment of inertia of the ship itself. This comes to our assistance in resisting sudden impulses. It is, however, the proximate cause of heavy lurching when the axis of rotation is shifted, if it be permitted to get the upper hand. This the apparatus should prevent. But lurching is a wholesome rebuke which commands us to think—and ask ourselves—how can this occur? And if this question be asked, and well considered, we believe that the answer which we have indicated above will be found to be the only one which points to a sufficient reason. And, if so, this apparatus would be an additional resource in the management of a ship. But, any way, the subject is so important, and the expense of trial so small, that if there were only half a chance of its succeeding, it ought to be tried; and I have no doubt will be when it becomes more generally and popularly known.

There is yet another topic which we can only just glance at. If the two rudders were placed at opposite ends of the ship, they would powerfully assist her steering by giving them an opposite inclination to each other. This property might be invaluable if a ship were on a lee shore or in other emergencies, the discussion of which, however, would exceed the scope of the present paper.

In conclusion, the author desires it to be understood that he does not pretend to be able to prevent disasters at sea. By the doctrine of chances extraordinary and fatal concurrences will certainly happen; but the author believes that, by the use of his apparatus, arranged for both steadying and steering, those chances may be diminished to an unknown extent, and when the simplicity and obviousness of the means are considered, it appears to the author surprising that the idea could have failed to present itself long ago.

* Writing a for the length of the arc traversed by the circle of gyration. f for the tangential force on the rudder reduced to that on the said circle. t for the unencumbered period of roll. T for the period after the rudder was put into action, and W for the weight of the ship, we should have—

$$T = t \times \left(\frac{W}{W - f g a}\right)^{½}.$$



THE 100 TON GUN AT SPEZIA, ITALY.

THE 100 TON GUN AT SPEZIA.

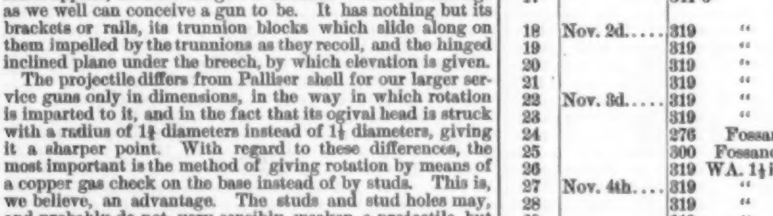
ITS total length is 32 ft. 10½ in.; calibre, 17 in.; length of bore, 30 ft. 6 in. The rifling is polygroove, consisting of 27 grooves and lands, having an increasing spiral from 1 in 150 calibres to about 1 in 45 calibres. It is at present unchambered, and is to have an enlarged chamber made in it shortly. It has a steel lining, wrought iron coils, and screwed cascable.

The carriage, if it may be called such, consists of two large plate iron brackets, or more truly rails, along which the trunnion blocks slide, carrying the gun On the rear of the trunnion blocks are two pistons, which, by the application of hydraulic power, are made to run the gun up or back, and to check its recoil. Elevation is given by means of an iron plate hinging horizontally at its rear extremity. The breech of the gun on recoiling comes back nearly to the hinge of the elevating plate, which is the proper height to bring the axis of the piece horizontal as it comes back fully to the loading position. The hydraulic power, applied directly to the trunnion blocks, is a great advantage, for the force of the recoil is met by a resistance opposite to its point of application. No moment or couple, therefore, tending to produce rotation or straining of any part of the structure is developed. If the hydraulic cylinders, etc., are strong enough to perform their work, the parts below ought to be almost in a state of repose. There are, however, hardly any parts to which such a remark applies, because the gun is as much without a carriage as we well can conceive a gun to be. It has nothing but its brackets or rails, its trunnion blocks which slide along on them impelled by the trunnions as they recoil, and the hinged inclined plane under the breech, by which elevation is given.

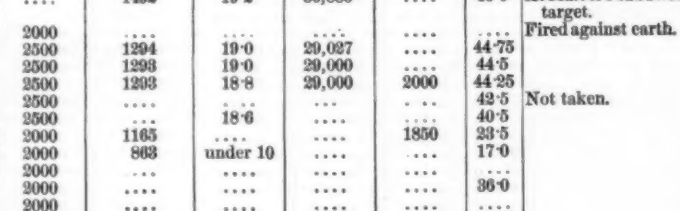
The projectile differs from Palliser shell for our larger service guns only in dimensions, in the way in which rotation is imparted to it, and in the fact that its ogival head is struck with a radius of 1¾ diameters instead of 1½ diameters, giving it a sharper point. With regard to these differences, the most important is the method of giving rotation by means of a copper gas check on the base instead of by studs. This is, we believe, an advantage. The studs and stud holes may, and probably do not, very sensibly weaken a projectile, but it is quite certain that this is their tendency, and projectiles have often shown a tendency to split through the stud hole. A cracked projectile has been most effectually broken by simply striking its stud a blow, and the words "mechanical cruelty" which have been applied to the system of imparting rotation to projectiles through studs let into them, are hardly a misnomer. With regard to the cartridge little is to be said. The powder used nearly throughout the experiments was our own Government Waltham Abbey manufacture of 1·5 in. cube, and the same method of ignition with interior hollow cone was employed as in the case of the 80 ton gun.

The series of rounds fired by the 100 ton gun is given in the following table:

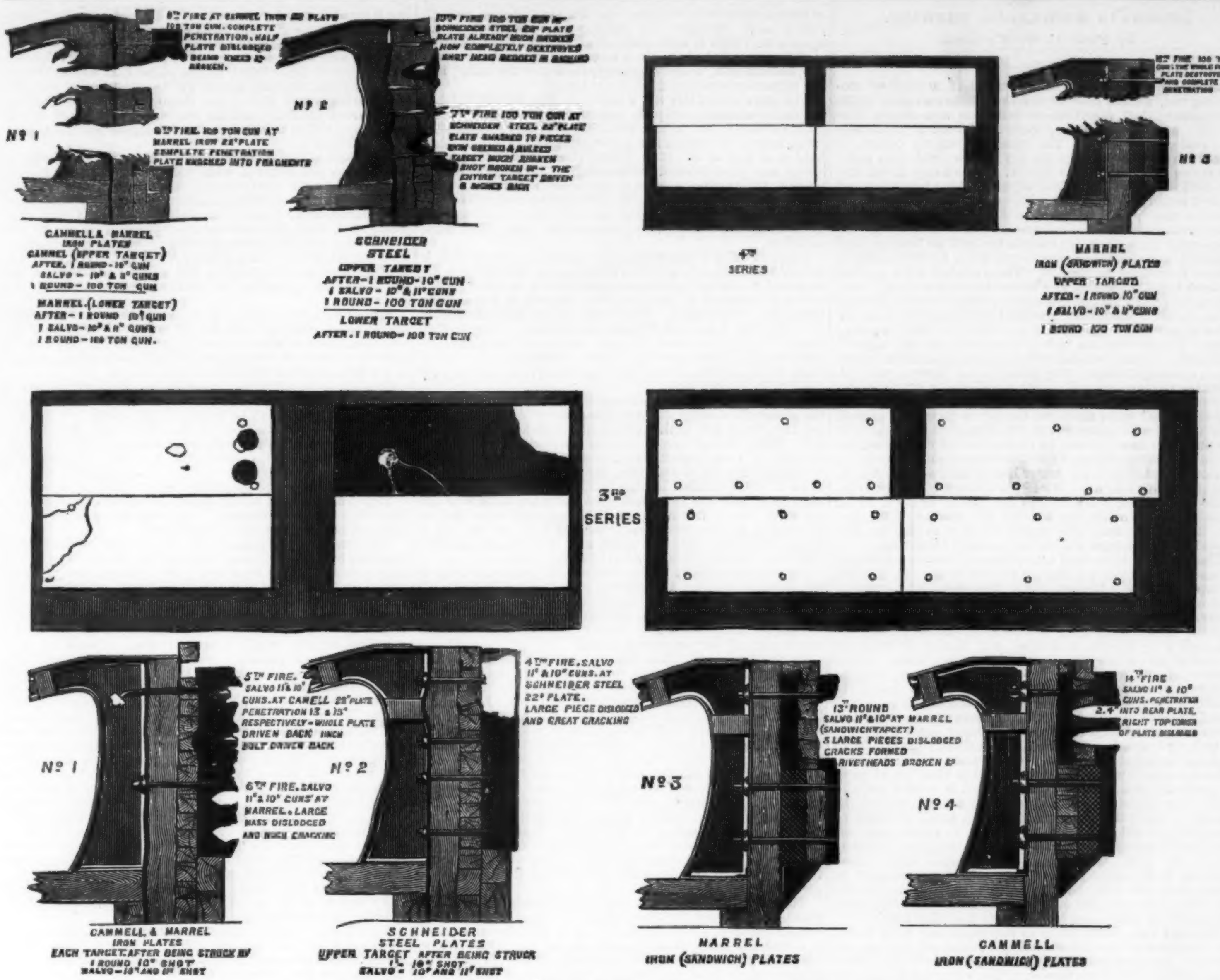
No. of Rounds	1876. Date.	Charge, weight and nature in lbs.	Projectile weight in lbs.	Velocity, feet per sec.	Mean pressure in bore.	Stored up work.	Recoil valves set to lbs.	Recoil in inches.	Remarks.
					Tons.	foot tons.			
1	Oct. 20th....	200 WA. 1½ in.	2000	not observed		....	1050	....	
2	Oct. 21st...	300 "	2000	not observed	16·6	....	....	....	
3		300 "	2000	1375	15·9	....	1150	....	
4	Oct. 23d....	300 "	2000	....	....	....	....	....	
5		300 "	2000	....	16·0	....	....	35·5	
6		300 "	2000	1374	16·0	....	....	37·5	
7		330 "	2000	1456	20·8	29,400	....	....	
8		319 "	2000	1424	18·0	28,120	....	42·5	
9	Oct. 25th...	319 "	2000	....	not obs'vd	....	....	44·75	
10		336·6 "	2000	....	19·4	....	....	46·3	
11	Oct. 26th...	319 "	2000	1437	....	28,625	....	42·6	At earth.
12		341 "	2000	1475	19·75	30,150	....	47·1	At Schneider steel plate.
13	Oct. 27th...	341 "	2000	1478	19·75	30,300	....	46·0	At Cammel's iron plate.
14		341·6 "	2000	....	....	....	....	....	Shot broken up in bore.
15		341·6 "	2000	1500	20·6	31,200	....	....	At Marrel's iron plates.
16	Oct. 28th...	341·6 "	2000	1493	20·1	30,920	21,800	48·2	At Schneider steel.
17		341·6 "	....	1492	19·2	30,880	....	46·0	At Marrel's sandwich target.
18	Nov. 2d.....	319 "	2000	....	....	....	....	....	Fired against earth.
19		319 "	2500	1294	19·0	29,027	....	44·75	
20		319 "	2500	1293	19·0	29,000	....	44·5	
21		319 "	2500	1293	18·8	29,000	2000	44·25	
22	Nov. 3d.....	319 "	2500	....	....	....	....	42·5	Not taken.
23		319 "	2500	....	18·6	....	....	40·5	
24		276 Fossano	2000	1165	....	....	1850	23·5	
25		300 Fossano's	2000	863	under 10	....	....	17·0	
26		319 WA. 1½ in.	2000	....	....	....	....	....	
27	Nov. 4th....	319 "	2000	....	....	....	....	36·0	
28		319 "	2000	....	....	....	....	....	
29		319 "	2000	....	....	....	....	35·25	
30			2000	....	....	....	....	....	
31			2000	....	....	....	....	....	
32			2000	....	....	....	....	....	
33	Nov. 7th....	353 "	2000	1512	....	31,700	....	42·5	
34		364 "	2000	1514	19·8	31,750	....	42·8	
35		375 "	2000	1542·8	21·4	33,000	....	....	At earth.
36	Nov. 8th....	319 "	2000	1348	....	25,200	....	....	
37		341 Fossano	2000	1415	....	27,760	....	....	
38		363 "	2000	1408	....	27,500	....	....	
39		363 "	2000	1444	13	28,900	....	....	



TARGETS BEFORE BEING FIRED AT BY THE 100 TON GUN.



TARGETS AFTER BEING FIRED AT BY THE 100 TON GUN.



TARGETS OF THE 100 TON GUN AT SPEZIA, ITALY.

The targets were built facing the sea. Opposite them was a battery consisting of one 11 in. gun with two 10 in. guns, one on either side of the 11 in. Further to the rear—that is, further to sea—was the raft on which the 100 ton gun was placed. As this gun is mounted for working in a turret, it has no provision for lateral adjustment or training. The raft, therefore, acted as a turret, the gun was "lined" as to direction by moving the raft, and the latter could be readily turned right round so as to enable the gun to fire for range out to sea. This was the part of the programme that was first carried out, the rounds from No. 1 to No. 10 being fired to test the performance of the gun as to the velocity it imparted to the shot and the pressure in the bore of the gun, and as to its strength and general behavior on firing, and also to test the action of the carriage. The most important matter in this firing is the velocity that can be obtained with such a pressure as may be deemed allowable for the gun. The highest pressure recorded is 20·8 tons per square inch, and this appears to be rather exceptionally high and irregular. The velocity corresponding to it was 1,456 ft. per second. The pressure occurring in the 80 ton gun during the first ten rounds with the full 16 in. bore was 22·0 tons, the corresponding velocity being 1,452 ft., the highest registered at any time with this calibre.

The plate experiments began on October 25. The construction of the No. 1 target consists of wrought iron plates, 24 in. thick on teak backing with angle iron and 1½ in. skin.

No. 2 is a similar target, except that 22 in. steel plates, supplied by M. Schneider, take the place of the wrought iron plates both in the upper and lower portions of target.

Nos. 3 and 4 are targets with what has been termed sandwich plating in the upper halves, that is to say, alternate layers of iron and teak, the front plate in each case being 12 in. thick, and the inner plate 10 in., as shown in Nos. 3 and 4, the only difference between the two being that in No. 3 Marrel and in No. 4 Cammell plates were employed. The lower portions of the two targets had wrought iron front plates 8 in. thick, No. 3 having a layer of teak next and then chilled cast iron 14 in. thick, and No. 4 having a similar thickness of chilled iron next to the front plates, the teak being all behind. The bolts of all the targets pass through the entire structure except in the case of the Schneider steel plates, into which the bolts were screwed to a depth of not quite half the thickness of the plate. The total thickness of wood in every target was the same, namely, 20 in., and the iron, exclusive of skin, was 22 in., the skin being 1½ in.—*The Engineer.*

THE ITALIAN 100 TON GUN.

This huge gun has been manufactured by Sir William Armstrong & Co. at the Elswick Factory, Newcastle-on-Tyne, Eng., for the armament, consisting of four such guns, of the Italian iron-clad ship Duilio. Our illustration, which is from the *Illustrated London News*, shows the general position of the gun as actually fired at the iron targets in the Bay of Spezia. It will be seen that the gun is mounted upon a pontoon or raft, measuring 60 ft. by 30 ft. The gun itself, as above stated, measures 32 ft., and it is without the usual carriage and slide, being supported simply upon two iron beams of half its own length, on which beams rest the stout hydraulic presses by which the movements of the gun are actuated as well as controlled. The pontoon floats in a little harbor provided for it by the construction of a little breakwater in the shape of an elbow; this protection is given in order to guard the pontoon, as far as possible, from disturbance by the sea, which might derange the experiments with the gun.

The iron targets are built up on shore; they are placed in a deep cutting in the mountain side, so as to furnish security from the flying of fragments. For the purpose of firing at high elevation—that is to say, to great distances—the pontoon is made capable of being turned round to a right angle, or one-fourth of a circle, in which position the gun may be fired out to sea to any distance. The trials against targets will be resumed next week. They have been suspended because it was found that the injury caused to the targets under the fire of the great gun, by racking and general shock, had been so great that even those targets which had not been fired at, but had been near to the ones actually struck, required repair before they could be submitted with fairness to their turn in the ordeal. Meanwhile, the experiments have been going on for the purpose of testing the efficacy of a peculiar powder manufactured by the Italian Government at Fossano.

It has been decided that the gun shall be increased in calibre to 17¾ in., when its charge will be 440 lbs. of powder, the weight of the projectile remaining the same, viz., 2,000 lbs. By this means a vast increase of power will be given to the guns of the Duilio and Dandolo without any increase of the strain on the gun, and the great results attained with the charge of 341 lbs. against the targets, and subsequently with the charge of 370 lbs., will be rendered more formidable in any future experiments.

A HORNET FLEET.

Not only are the railway and the telegraph making their way in the Celestial Empire, but other strange and wondrous innovations are finding favor in Mandarin eyes. Above all, the Chinese Government are determined to become a considerable naval power, probably because they are a little afraid of their neighbors of Japan. They have already become possessed of steam frigates, and it is not improbable that orders for an ironclad ship or two will reach this country ere long. The Chinese Government have, however, very wisely determined not to wait for big ships, but to keep pace with the times by procuring big guns and little ships, which can be obtained, comparatively speaking, at a moment's notice. In other words, they are forming the nucleus of a hornet fleet, which fleet, if properly manned, will, no doubt, give a great deal of trouble to Japan, or any other country which may dare to invade the sanctity of Celestial waters. Sir W. Armstrong & Co. have been constructing certain powerful gunboats for China. These boats lately have been tried off the mouth of the Tyne, and Gen. Sir Lintorn Simmons, Col. Nugent, R.E., and several other officers of the English army were present. Two of these boats, each mounting a 26½-ton gun, have already been delivered at Tientsin, and two remaining boats, each of which will mount a 38-ton gun, are now all but complete and ready to start for China. These little vessels are improved "Staunches." They each measure 126 ft over all; their extreme breadth is 30 ft.; their draught of water 8 ft.; their displacement 400 tons; and their twin screws propel them at 9 knots. They carry 50 tons of coal, 50 rounds of ammunition weighing 25 tons, two 12-pounders, and a Gatling gun; and they are schooner rigged with tripod masts. The two boats which have already reached China made excellent passages, in spite of their small size, and there is no reason to doubt that the Gamma and her consort will be equally successful. It will be remembered that the Staunch invented by Mr. Rendel carries her gun on a species of lift, so that it can, when not required, be dropped altogether below the deck and out of the way. But the gun itself is mounted on a carriage very much in the ordinary way. In the Chinese boats, however, much larger guns are used than that in the Staunch, and the little vessel is herself the gun carriage. Two heavy iron beams in the fore part of the vessel run side by side on a level with the deck, and parallel with the keel. On these beams are bolted frames precisely analogous to the slide bars of a horizontal engine, and the slide blocks carry the trunnions of the gun; these last taking the place of the crosshead pin. Thus arranged, the gun can slide backwards and forwards through a range of about 3 ft. The preponderance at the breech end is supported by two secondary parallel bars inside the main gun beams. These are hinged at the rear end, while at the forward end they are carried on the cross head of a vertical hydraulic ram fixed beneath the deck. The breech end of the gun is supplied with a hoop and lugs; the lugs rest on the two secondary bars near their hinged ends, and thus by causing the hydraulic ram to rise or fall, the gun can be elevated or depressed at will. No turning gear is provided, the azimuthal sweep of the gun being effected by turning the whole boat through the required arc by the use of the rudder and the twin screws. To run the gun in and out two hydraulic cylinders are used; one is fixed horizontally on each side beam, the crossheads of the rams laying hold of the trunnion side blocks. The recoil is taken up by these rams delivering water under a weighted valve. In a word, the entire arrangement of the mechanism is almost similar to that adopted with the 100-ton gun at Spezzia. The gun is loaded by a hydraulic rammer, the shot being placed on a little carriage or trolly, off which it is pushed into the chase. So well is everything arranged that the commander, standing in a splinter proof to the rear, can, by suitable handles, load, elevate, or depress the gun, and steer the ship by the aid of hydraulic steering apparatus. The gun was fired twice during the late trial trip, with perfect success, one of the charges consisting of an 800 lb. shot and 100 lb. of powder, while the other consisted of a projectile of the same weight, the weight of powder being increased to 130 lbs., the elevation being 3¼ degrees.—*The Engineer.*

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MacCord.

Second Series.—No. VI.

Returning now to the consideration of the link or connecting rod, we first observe that the "strap and end," as the arrangement last described is called, is not always convenient; and, indeed, it is by some considered objectionable under all circumstances. The reason given, we believe, is that it is very easy to drive the key too far, and thus make the brasses bind the pin too tightly. It is not easy to see how any device which is capable of adjustment can be made proof against maladjustment; but without stopping to argue the question any further, we give in Fig. 41 a drawing of another arrangement. The end of the rod is here spread out into a solid mass, in which the pin has half its bearing, and extended on each side to receive two bolts, by which a cap or binder is secured to the rod. There are tap bolts, passing through holes in the cap, and screwed into the "lugs," into which the end of the rod is formed; passing entirely through these, the bolts are further provided with jam-nuts, as an additional safeguard against the possibility of their working loose. The head of the bolt is hexagonal for the application of the wrench; but below the hexagonal part it is formed into a cylindrical collar, thus giving a fair bearing, and distributing the pressure with perfect uniformity over the surface of the shoulder. In order to prevent, as far as possible, any side strain upon the bolts, the cap is formed so as to fit into a recess planed across the end of the rod, and the bolts are placed as near as may be to the sides of this recess, for the sake of compactness, as well as because they ought to be as close as possible to the center line of the rod, which is the line of the direct strain. It will be observed that the cylindrical collar of the bolt cuts into the "fillet" or curve which joins the crown of the cap with the flat surface of the lug; but it is better that this should be so than that the lugs should be made longer and the bolts placed farther apart.

The cap itself is made of brass, but as it was not considered necessary to introduce a brass in the end of the rod, its place is supplied by anti-friction metal hammered into a recess, which is shown in dotted lines; and this is made more conspicuous by sectioning the metal. It will be noted, however, that the sectioning is done in full lines, just as though the rod itself were drawn in section; and it may be remarked here that this is very frequently done when some interior portion of an object, drawn in elevation, is to be brought prominently into notice; the effect is much better than if the sectioning be done in dotted lines, as it sometimes is, which usually results in making a confused mass of dots, or, rather, short dashes, the solid effect aimed at being entirely lacking. In making a working drawing, this sectioning should be in blue, as the metal itself is of a bluish cast.

In this case, it will be evident that a top view would be of no particular use; the only thing which it would serve to define more clearly than the other views do, and, indeed, the one thing which they do not define at all, is the thickness of the wall to be left at the sides of the rod to confine the soft anti-friction metal; but such an item as that may be safely left to the good judgment of any mechanic who is competent to fit up such a piece of work—or, if the designer be afraid to trust to that, he may indicate it by drawing, on the end view of the cap, the outline of the recess to be filled with the metal—in which case he should do it in blue lines.

This end view, however, is an important one, as it shows the thickness of the whole, and the forms of the lugs; as these are the same in both cap and rod, it is as well to make it an outside view of the former, which we have done, placing it at the left accordingly. The center lines of the bolts should be, as shown, continuous, as they thus lead the eye from one view to the other, and show the relation of the views to each other better than if they be made, as they sometimes are, in parts; that is, interrupted between the front and the end view. On one of them may be drawn an end view of the bolt, which allows us to omit the bolts in the end view of the cap, the holes only being shown, which at once saves labor and makes the drawing clearer, as indicating more distinctly the cutting into the fillet, above spoken of. This is also made clearer in the front view by omitting one of the bolts there too, showing the hole in the cap, countersunk, where necessary, to receive the collar, and the tapped hole in the lug of the rod itself.

The other end of this rod is shown in Fig. 42. It is fitted up, in the manner previously described, with brasses straps, gibs, and keys; but differs from the previous examples in being forked, or formed into a jaw, each side of which takes hold of an end of the pin. Under these circumstances the straps are proportioned substantially, as previously explained, their aggregate area in the thinnest part being some twenty-five per cent. greater than that of the neck of the rod, and the dimensions of the other parts of each strap, as well as of the gibs and keys, being determined from these data, as before.

This rod being a short one, the "shank" or body of it is of uniform diameter; and the distance, $a\,b$, having been determined, a center, c, in the prolongation of $a\,b$ is taken, about which is described a quarter circle tangent, at d to $d\,e$, the upper line of the shank. The inside of the jaw, as seen in the top view, has a semicircular termination, in regard to which it is to be noted that the center e of the semicircle must not lie to the right of d' (which corresponds to d in the front view), though it may lie to the left if it is necessary for the jaw to be very long.

We come now to an important consideration, in respect to the means of making a neat and workmanlike finish in joining this broad jaw to the comparatively slender neck of the rod. Many draughtsmen content themselves with merely indicating, in a general way, something near what they would like the rod to look like, but do not take the pains to draw it with precision, leaving much to the judgment of the mechanic; and we are afraid that there are some who are not quite sure of just what would be the result were they to attempt to give specific directions. So long as the rod is strong enough, it may not make any momentous practical difference whether it be finished one way or another; but we hope that the majority of our readers will agree that there is no harm in aiming at neatness and elegance in design, if strength be not sacrificed thereby; and, at any rate, we shall assume that they wish to be able to give positive directions, to know exactly what will follow, and to represent that result with all the accuracy required.

In the first place, then, the rod being turned, there will evidently be a curve, $f\,g\,h$, formed by the intersection of this surface of revolution with the plane side of the jaw. Were this curve a semicircle with center e, the effect would be unpleasant, although no doubt the fork would be strong enough; but it will look much better if $g\,l$ is greater than $j\,d'$, and $h\,k$ greater than $g\,l$. The question then is, what will be the outline of the surface of revolution, which will give an intersection to suit our taste? We cannot assume the outline at random, though we might "cut and try," assuming an outline first, finding the curve of intersection, and, if it were not what we wanted, altering the outline, and so on until we should possibly hit the mark. But a much more certain and satisfactory way is to reverse this order of proceeding; if we can determine the curve when we know the outline, we can ascertain the outline if the curve be given.

Therefore we will assume a curve of intersection; and as good a way as any we know of to set about that, is to assume a center o, a little to the left of e, and describe about it a semicircle tangent to the outer line of the fork. Knowing, from Figs. 23, 38 and 40, something of the nature of the desired curve near the vertex u, we may then draw such a line at pleasure, tangent to this semicircle at x, between h and g. From this, then, by a reversal of the process explained in connection with Fig. 23, we may construct a meridian outline. This operation is illustrated in Fig. 43; the cutting plane $L\,L$ being tangent to the side of the rod as shown, the point 1 is projected to 1', revolved about C to the position 2', which is again projected to 2, vertically under 1, which is a point in the required outline. If we draw a line 2-3, parallel to the center line of the rod, or axis of revolution, that line will generate a cylinder; and if about o we describe a semicircle with radius o 2, that in revolving about the same axis will generate a sphere tangent to this cylinder. The section of the cylinder by the plane $L\,L$ will evidently be a rectilinear element, which will by construction coincide with the horizontal line drawn through 1, that is, with the outer line of the fork; and the section of the sphere by the same plane will as evidently be the semicircle described about o with radius o 1.

For a part of our meridian outline, then, we have only to describe an arc about o, with radius o 2; just what part is determined by the consideration that at the point x the assumed curve of intersection ceases to be circular; and were x projected to $L\,L$ at x', revolved to 4', and 4' then projected to 4, vertically under x, this last point would be the one in the meridian corresponding to x in the intersection, whether the latter were a circular arc or not. We need not then go through this process, but may simply describe the arc 2-4 about o, cutting the vertical line through x in the point 4.

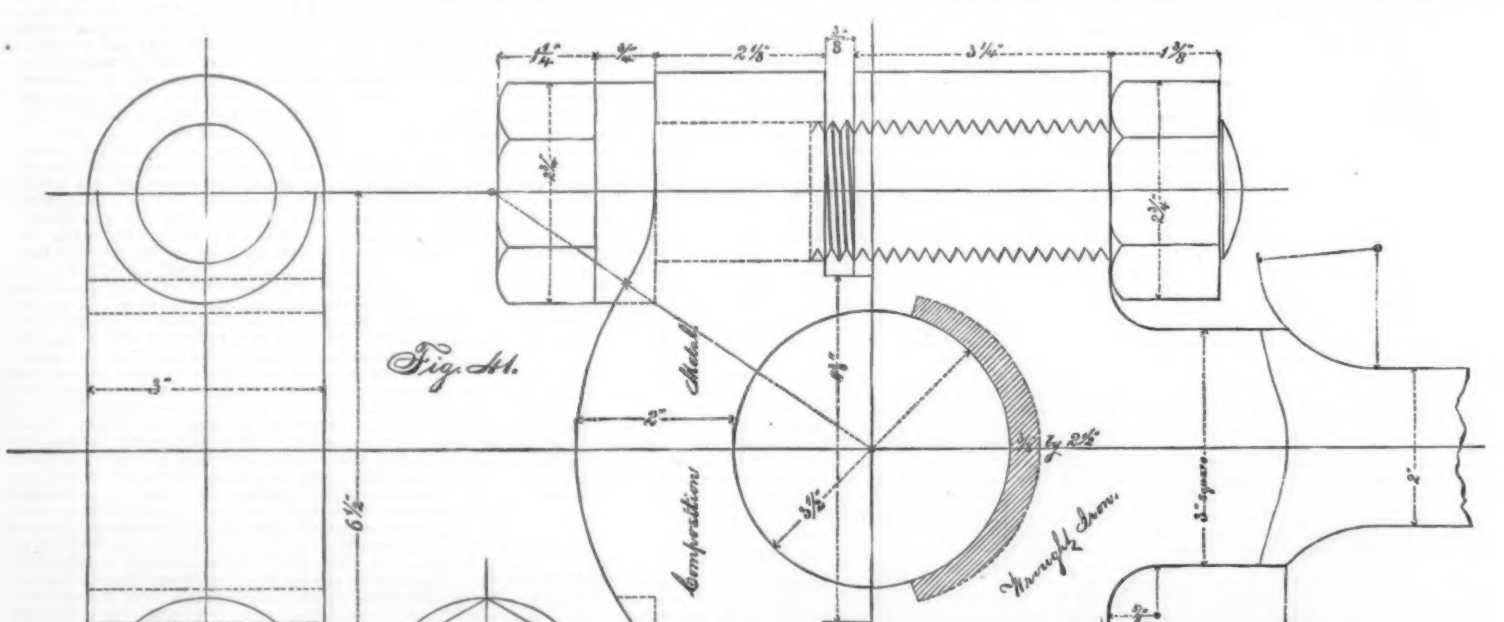
From x to u, however, we must repeat the above described operation a sufficient number of times to determine the meridian outline with reasonable precision, if we wish to make sure that our assumed curve shall make its appearance as we have drawn it when the rod is finished.

But it is to be noted that, in assuming the terminal part of this curve, there is no certainty that the meridian outline corresponding to it will be tangent to the outline of the rod. And it is more essential that it should be than that the intersection should be precisely what we may have assumed. In order to secure this desideratum, it is better to complete the meridian outline by a circular arc, tangent to the arc 2-4 at the point 4, and also to the side of the rod, as shown.

This done, find the remainder of the curve of intersection from this outline, substitute it for the assumed curve, and this part of the work will be completed.

But something yet remains, for the outside of the fork is bounded by plane surfaces, forming the broad faces of the stub ends seen in the front view, and it would present a very unsightly finish were these planes simply extended to cut the solid of revolution of which we have just completed the outline. In order to avoid this, we find on the line o 1 a center z, about which an arc is described tangent to the meridian outline, which practically may be done by trial, though we shall presently give a method of finding it geometrically. The side of the fork being then finished by filing or slotting to this arc, perpendicularly to the paper in the top view, it will be seen that the arc itself represents a part of the base of a cylinder, whose radius is z 1; this cylinder will cut the surface of revolution in a curve seen in the front view, and the determination of this intersection completes the drawing. This is readily made, thus: if we suppose the rod to be cut across by a plane perpendicular to the axis, say at the point s of the arc last mentioned, it will cut from the cylinder an element, seen in Fig. 43 as $s'\,t$, and from the surface of revolution a circle, seen in the same figure as $s'\,t'$; their intersection s' will be a point in the required curve, seen in the front view as s'', its distance $s''\,t''$ above (or below) the center line being equal to $s'\,t$ of Fig 43. In a similar manner we may find as many more points as may be needed—the curve terminating at w'', corresponding to, and vertically under, w, the point of tangency of the base of the cylinder and the meridian outline.

Now it may seem to some that all this involves a good deal of labor, which we are not going to dispute, although its amount depends largely on the facility with which the operator handles his instruments. Be the same more or less, however, we insist upon it that it is labor well bestowed, and that at least the meridian outline ought in all such cases as this to be carefully determined, indicated either in dotted lines, as we have shown it, or in red, and that attention should be specially called to it by a note on the drawing as well as by verbal instruction to the mechanic when the work is "put in hand." If the *finished* outline only is shown, nothing is more natural than that the workman, knowing that the shank



LESSONS IN MECHANICAL DRAWING. SECOND SERIES.—No. 6.

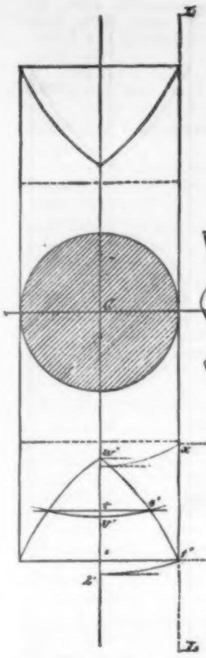


Fig. 43.

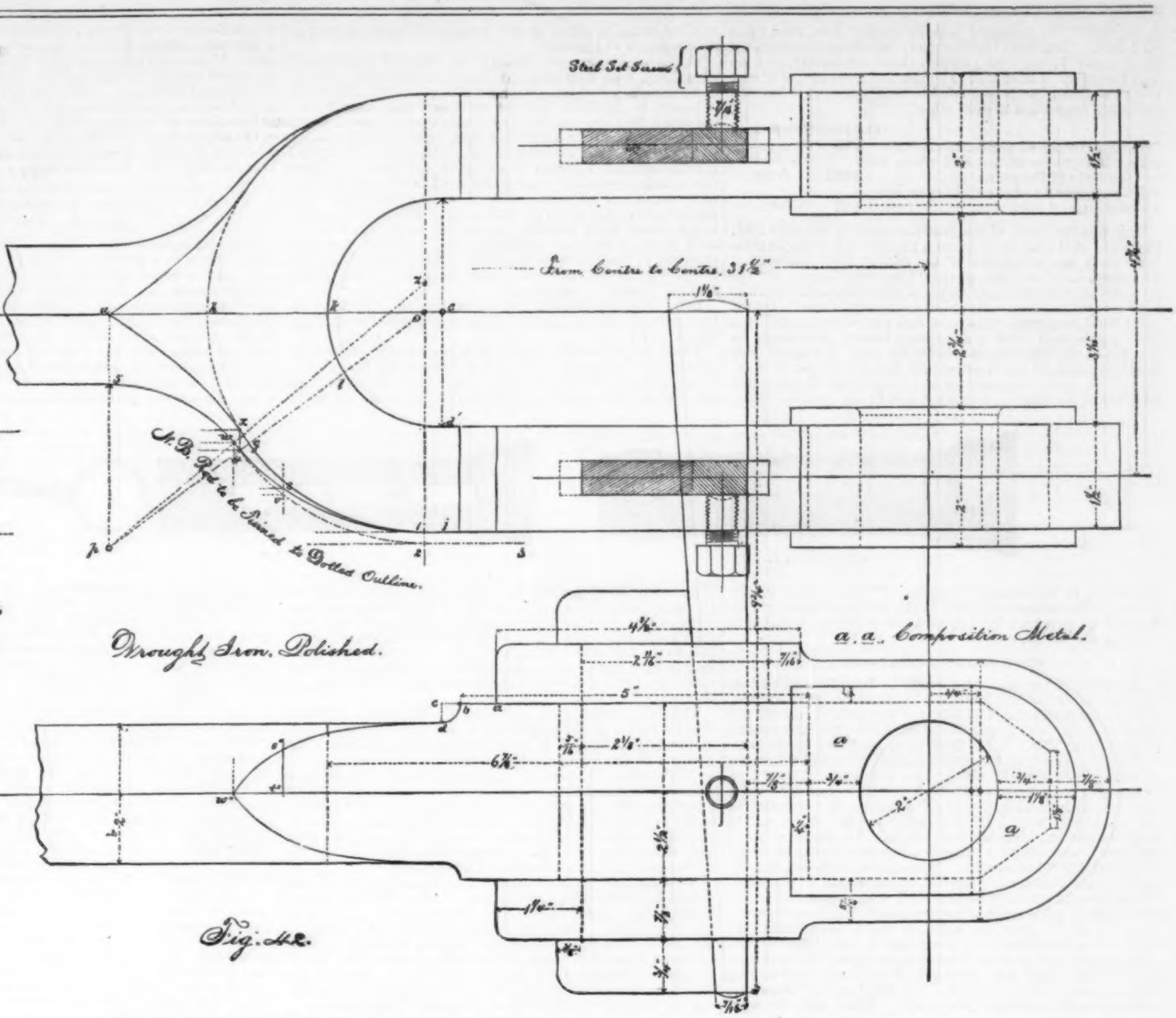


Fig. 42.

LESSONS IN MECHANICAL DRAWING. SECOND SERIES.—No. 6.

is to be turned, should imagine that he is to work to that; and we have known cases in which a neglect of the precaution here insisted on has nearly led to the spoiling of an expensive piece of work, for the reader will at once see that, if the tool were guided by the full outline while the rod was in the lathe, a square shoulder would be formed where the arc becomes tangent to the outer line of the fork in the top view, and the curve of intersection would be entirely different from that shown.

As a matter of practice, the student is advised to make these drawings of the full size, all the dimensions being given.

It is not of course necessary that the full length of the rod, as given, should be drawn; the ends only, as shown in the figures, are necessary for the workman, if he be told that

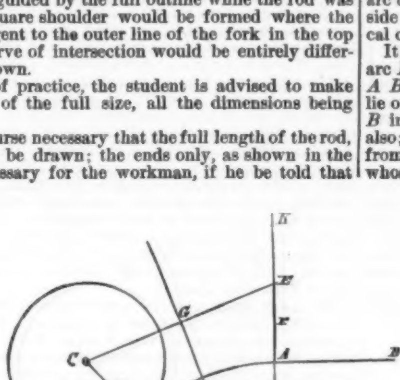


Fig. 44.

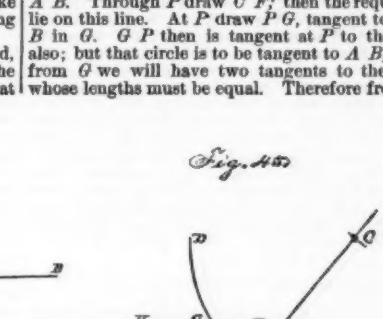


Fig. 45.

the shank of the rod is to be "parallel," that is to say, of uniform diameter, and the distance between the centers be stated; though a 3-inch scale drawing of the shank may very properly be furnished also, which will save some time and give additional security against mistakes.

We give in Fig. 44 a geometrical solution of the problem above mentioned, the finding of the center Z of Fig. 42. Let C be the center of a given circle whose radius is r, $A B$ a given line; it is required to find the center and radius of a circle which shall be tangent to the given circle, and also tangent to $A B$ at the point A.

Draw through A the line $K D$ perpendicular to $A B$; on it set off $A E = r$; draw $E C$, bisect it by the perpendicular $G F$ cutting $K D$ in F; then F is the center sought. For, drawing $F C$ cutting the given circle in H, we have two triangles, $C G F$, $E G F$, right-angled at G, with equal bases $G C$, $G E$, and the common side $G F$; they are therefore similar and equal, and $C F = E F$; subtracting from these the equals $C H$, $E A$, we have $H F = A F$.

A somewhat similar problem is involved in the determination of the center p and radius p 5, in Fig. 42, so that the arc 5–4 shall be tangent to the arc 2–4 at 4, and also to the side of the rod. This may be done by trial; but a geometrical construction is given in Fig. 45.

It is required to draw a circular arc, tangent at P to the arc $D E$ of which C is the center, and also to the given line $A B$. Through P draw $C F$; then the required center must lie on this line. At P draw $P G$, tangent to $D E$, cutting $A B$ in G. $G P$ then is tangent at P to the required circle also; but that circle is to be tangent to $A B$; that is to say, from G we will have two tangents to the required circle, whose lengths must be equal. Therefore from G set off on $A B$ the distance $G H = G P$, and draw $H K$ perpendicular to $A B$, cutting $C F$ in K; then K is the center and $H K$ the radius of the required arc $H P$.

PIPES FOR GAS AND OTHER PURPOSES.

THE first street mains laid down by Winsor, in Pall Mall, were of lead. These were not constructed like lead pipes at the present day, but simply of sheet lead, of varying thickness, proportionate to the diameter of the pipe, bent round a mandril or core, and soldered at the edges. This was in 1807; but on the introduction of cast iron pipe, a few years afterwards, the leaden tubes were removed and replaced by the latter.

Murdoch's first mains were of tinned iron and copper. In the lighting of Messrs. Phillips & Lee's mill and other premises in Lancashire, between 1805 and 1808, his mains varied in diameter from 5 inches downwards; the larger size being of cast iron, and the smaller tubes of sheet iron.

The New River Company began to make use of cast iron mains in the year 1810; prior to that time their pipes were chiefly the trunks of elm trees, bored by means of augers to the required size; the exteriors being left in their natural rough condition. We are not aware that these wooden tubes were ever attempted to be employed in the distribution of gas. Wood gas pipes, however, are at the present time somewhat extensively used in the United States. They are principally made from tamarck logs, and are of great durability when laid in wet soils; the leakage from them is said to be but small. When Clegg accepted the post of engineer to the Chartered Company, in 1813, the first mains he employed were of cast iron, and 2 inches in diameter.

THE CHAMEROY PIPE.

A peculiar description of pipe was, sometime ago, invented by M. Chameroy, a Frenchman, which has been extensively employed in France and the continent. It is formed of tinned sheet iron, bent into cylindrical lengths, which, on being riveted and soldered, are coated on the exterior with a layer of asphalte intermixed with sand, of from a quarter to half an inch thick. The iron sheets range in thickness from that of ordinary tin plate up to No. 16 gauge, according to the diameter of the pipe to be constructed.

The method of manufacture is as follows: The sheet iron, which is leaded, is cut, according to the required dimensions, into lengths of about 2 mètres (6 feet 6 inches), and after having been riveted with tinned rivets, 3 inches apart, the pipes are soldered throughout their entire length by plunging the joints into a lead bath. The two lengths are afterwards united together by rivets and tin solder, to obtain a total length of 4 mètres (about 13 feet). Previous to 1855, the joints were made by a metal screw run on to each extremity. The inconveniences which this system of jointing presented—notably the impossibility of making pipes of greater diameter than 12 inches, the difficulty of screwing the joints together in their places, the employment of special tools, and, above all, the effect of torsion to which the pipes had to be submitted—caused this species of joint to be abandoned, and it has been replaced by a socket joint, which may be applied to all diameters. This joint, composed of an alloy of lead and antimony, is formed of an exterior cylindrical part run upon one of the ends of the pipes, and sliding by friction into a socket of the same metal run into the other end. This joint is easy of application, and forms a compensator, which gives to all the separate pipes the faculty of expanding and contracting, according to the variations of temperature. After having run upon the pipes the rings which constitute the joint, they are tried under a hydrostatic pressure of eight or ten atmospheres. The exterior surface is tarred over, and a cord is wound round, after which it is plunged alternately in a bitumen bath, and rolled in fine gravel, till a layer of this coating is obtained five-eighths of an inch thick for pipes of 28 inches in diameter, and one-fourth to five-sixteenths of an inch thick for pipes of smaller dimensions. The pipes are then finished by being rolled upon a table in fine sand. The plumbing work of the service-pipe is easily performed, in consequence of the presence at all points of the pipe of leaded sheet iron,

upon which the soldering is more readily done than upon lead itself. The Paris Gas Company, whose unaccounted-for gas is under 10 per cent., employ them extensively, and report favorably of their use. The loss per 1,000 mètres of cast and sheet iron pipes is estimated by their engineer to bear the following proportion to each other:

	Cast Iron.	Wrought Iron.
In consequence of accidental ruptures	1·60	0·46
In consequence of use and waste in the body of the pipe..........	0·353	0·198
In consequence of the shaking or disturbance of joint..................	1·77	0·52

This was the result of observations made in the year 1861, and since that time the company, in replacing their canalization when the exigencies of the supply have rendered it necessary, have substituted the "Chameroy" pipes for the previous ones of cast iron. Some of these pipes laid down in 1837 are still in wear, and exhibit no signs of decay. On the other hand, engineers who have had experience in their use have condemned their employment, though principally on account of the difficulty of making the joint. No doubt their durability and efficiency altogether depend on the care bestowed on their construction, and the amount of protection afforded to the jointed parts when laid in the ground. They are known by the name of "Chameroy" pipes, after the inventor. One serious objection to the sheet iron pipes is their liability to puncture by the picks of workmen engaged in opening the streets.

WOOD AND ASPHALTE PIPES.

An attempt has also been made to introduce pipes constructed of wood and asphalte, but with no great success. These were manipulated as follows: A cylindrical mould, the same diameter and length as the intended pipe, was formed of sheet iron. This being fixed to an axle, and made to revolve at a speed, at its circumference, of about 6 feet per minute, pieces of wood, one by one, were laid and bound on it by one or more lengths of hoop iron 1-20th of an inch thick and half an inch wide, drawn off a reel by the revolution of the cylindrical mould, friction being applied to the reel to keep the binding iron sufficiently tight. The pieces of wood employed were about a quarter of an inch thick, 18 inches long, and 3 to 6 inches wide. These were creosoted, and the grain of the wood ran obliquely to the length of the piece. When the pipes were to be furnished with spigot and socket joints, these, being made of cast iron, were driven on the ends. A jacket of thin sheet iron was then bound closely round the outside, the whole heated to about 230° F., and being set upright, asphalte, in a state of fluidity, was poured in at the top between the inner and outer cylinders of iron, and flowing down amongst the pieces of wood, filled up the interstices, making a solid concrete of the whole. When cold, the inner and outer sheets were removed. The thickness of these pipes, which was in proportion to their diameter, was increased or diminished by giving the pieces of wood greater or less lap.

PAPER PIPES.

Pipes of bitumenized paper have also been manufactured and tried, but, though high anticipations were at first formed of their success, the result has not been such as to warrant their extensive adoption. These pipes are made by passing an endless band of paper, as wide as the length of the pipe, through melted bitumen, and rolling it round a cylinder, the circumference of which corresponds with the diameter of the pipe to be manufactured, until it obtains the required thickness. Another cylinder passes over the paper that is impregnated with bitumen, so as to spread the latter over it equally. The pipe, after being cooled and removed from the interior cylinder, is coated inside with a fine and insoluble varnish, and the exterior is covered with a mixture of bitumen and fine gravel. When pipes of this description are used for gas, it is absolutely indispensable to line them with a thin coating of lead, and even in that case the hydrocarbons may penetrate to the bitumenized paper, and rapidly decompose the pipes.

CEMENT PIPES.

Cement, concrete, and earthenware pipes have been tried in some foreign towns, owing to the difficulty at one time experienced in obtaining cast iron pipes, and their great cost; but these have invariably proved a failure. A tile main was laid down by the Cambridge University and Town Gaslight Company about 34 years ago, but has long been discontinued on account of the unsatisfactory results obtained from it in regard to leakage, and the objections to drilling for the insertion of services. This pipe was the leading main from the works, and was half a mile in length. The tiles were made of Newcastle fire-clay, 12 inches in diameter, and 2 or 2½ inches in thickness; they resemble the ordinary draining tiles, with the exception that they were in two halves, rebated, and overlapped, fitting one upon the other, being jointed with Roman cement.

SLATE PIPES.

In 1860, M. Sébille, of Angers, discovered a means of making pipes from slate refuse, formed into a paste with a melted resin solution, and moulded to the required length and shape. The pipes, which hardened on cooling, became strong enough to resist a pressure of twelve atmospheres. They were incorrodible, and unaffected by acids. The inventor claimed further advantages for these pipes on account of their cheapness, and for the facility with which they could be lengthened, joined, and repaired. For joining one pipe to another, M. Sébille used an instrument which, on being applied red hot to the ends, softened the material, and so united them together. Cracks were repaired, and services inserted in the same way. Notwithstanding the apparent success of the invention, the pipes have not been adopted to any great extent.

CAST IRON PIPES.

It is generally admitted that cast iron is the material best adapted for the manufacture of main pipes. These should be of equal thickness throughout their length, with the exception of the socket, which ought to have a slightly thicker body of metal, to afford greater strength to resist fracture in the operation of jointing.

Unless pipes are cast vertically in dry sand moulds and loam cores, with their socket or faucet downwards, it is not to be expected that this condition of regularity in the thickness can be fulfilled; and yet we know that, oftener than otherwise, they are cast either horizontally or in but a slightly inclined position. We find, in consequence, that, in drilling such mains for the insertion of the service pipes, the metal is frequently not a quarter of an inch in thickness, and even this is further reduced by careless or unskillful workmanship, or by the use of improper tools in making the holes. We admit having seen pipes of various sizes that have been cast in an almost level position, as regular in the thickness of their crust as any cast vertically; but great care has been observed in their manufacture; and certainly the chances of irregularity in thickness and solidity of metal, by the former method of casting, are many.

Belts or bosses, about a yard apart, are sometimes cast on the pipes, to insure a proper thickness of metal in drilling. (See Fig. 1.)

These are, no doubt, useful, and answer the purpose intended, to some extent; but it will be apparent that in frequent instances the service pipes have to be diverted from the straight line to admit of the belt or boss being available.

Fig. 1.

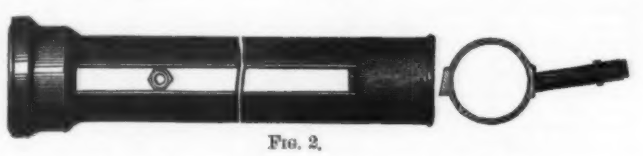


Fig. 2.

To obviate this objection, Mr. Cathels, of the Montreal Gas Company, some years ago patented a pipe having two continuous ribs running longitudinally, one on each side, with their faces either vertical or slightly inclined upwards, suitable to the fall of the services, Fig. 2. If preferred, the ribs may be cast higher up on the sides of the pipe, and the services attached by obtuse connecting bends, or there may be only one rib on the top of the main.

The ribs extend from the back of the socket to within about 9 inches of the spigot end of the pipe, and are 2 or 2½ inches in width, and of such thickness in addition to the strength of the pipe as to give a total thickness of about an inch of metal. On being drilled and tapped, they afford a sufficient threaded surface for the service pipe, and to secure a perfect joint. In the casting of such pipes, extra care has to be exercised to prevent unequal construction in cooling, and hence arises a slight increase in their cost over the ordinary description; but this is amply compensated for in the advantages their use is calculated to afford.

All cast iron pipes intended for the conveyance of gas should be tested with a pressure of at least 150 feet head of water, being equal to about five atmospheres, or 75 lbs. on the square inch. This is requisite in order to detect flaws in the metal, such as blown places, blisters, shrinkage cracks, and sand holes; and, whilst under such pressure, they should be smartly rapped from end to end with a hammer; the sound emitted—dull or bell-like, as the case may be—indicating the presence or otherwise of flaws and imperfections.

Of one thing we are assured, that there is no saving in badly constructed pipes, however low the price at which they may be obtained. We have, in the course of our experience, seen mains being laid that would have been dear as a gift.—*Journal of Gas Lighting.*

ABOUT PEAT STEEL.

The great interest attaching to the Dodge process, so far as the readers of the *Mining Journal* are concerned, results from its importance in facilitating the production of peat charcoal, for it is stated that at the Syracuse Works they are also carbonizing the condensed fuel, and producing a charcoal weighing 46 lbs. to the bushel, whilst good wood charcoal weighs but 20 lbs. to the bushel; they expect to be able to furnish peat charcoal at $4 per ton, which is about one half the price at which wood charcoal is sold in the lowest market in the United States. It is claimed that with the Syracuse fuel the iron and steel manufacture can be revolutionized, as there are large beds of peat all over the Northern States, as well as in Canada. For gas fuel peat is also said to be particularly valuable, an analysis made at Montreal showing that it is capable of producing 13,000 feet of illuminating gas to the ton. It is estimated that machinery for a set of works, capable of producing 80 to 100 tons of dry peat daily, at a labor cost per ton of not exceeding $1, can be put up for from $5,000 to $6,000, or (say) 15,000*l.* in England, exclusive of the cribs for drying.—*London Mining Journal.*

ADULTERATION OF SOAP.

If we consider the very large consumption of soap which takes place in some of our mills, does it not appear strange that this article of commerce is subjected to such trifling tests, and receives comparatively little attention at the hands of our textile manufacturers? The surprise is to us all the greater, since soap is so easily adulterated; thus, by the use of palm and cocoa nut oil in its manufacture, it is well known that soap is able to take up fifty, sixty, nay, even from eighty to one hundred, per cent. of water without losing any of its solidity or hardness.

Consequently, it may easily happen to every soap purchaser that in the buying in of what he considers a cheap soap, he is actually receiving only half soap, and paying for the other half of water at the same price. A good quality of soap, we may interline, ought only to contain from ten to twelve per cent. of water; and, comparing this percentage with the ones previously given, a few of the simplest tests for the detection of such soap adulterations will prove useful to such large consumers as many of our readers undoubtedly are:

Test I.—Dry a given weight of soap at a moderate heat, and, when dry, reweigh it, when the difference in weight will show the amount of water added.

Test II.—*The So-called Spoon Test.*—Whereas a good quality of soap sometimes shows dark and light shades, it soon changes into a dark shade if a spoonful of soap be held over a spirit or other flame, and, although it becomes soft, it does not, if good, become liquid, as occurs with an inferior quality.

Test III.—*Separation by Salt.*—Weigh a certain quantity of soap, and, cutting it up into small pieces, allow it to melt in a pan of water placed over the fire, adding a handful of salt to the water, and allowing it to boil. The soap-lather should not run over the pan, or overboil. Now try and see if the soap allows itself to be easily separated from the water: if not, add some more salt till this takes place, when the whole may be allowed to cool, skimming off the lather, drying and weighing it. As in the previous case, the loss of weight between the first and last weighings represents the adulterations of the soap. It is, of course, quite immaterial to the soap consumer whether this adulteration results from an excess of water, or of soda, or of some other ingredient. *Centralblatt fur die Textil Industrie.*

FALSE BEESWAX.*

By Gustav Hell.

The author relates that a short time ago an article was offered for yellow beeswax, which, on account of the moderate price, sold largely, and which he has determined to be entirely factitious. The appearance of this false wax is almost identical with that of genuine beeswax. In color, brittleness, fracture and adhesiveness, the difference is very slight. On the outer surface the characteristic honey-like smell, although faint, was distinctly perceptible. The freshly cut surface, however, has not the same lustre as in genuine wax, and the freshly fractured surfaces give marked pitchy odor. Melted at a gentle heat the smell of honey is lost, and the pitchy odor asserts itself in an unmistakable manner; at a stronger heat it becomes intense, and persists for a long time. Having ascertained in this simple manner that the article in question was one containing a considerable proportion of pitch, the melting point and specific gravity were determined in the usual way, as follows: A glass flask, with a wide mouth, was three-fourths filled with water, and a test tube containing small pieces of wax and a thermometer was sunk to the center of the flask, and the latter lightly closed. The contents of the flask were then slowly warmed by means of a spirit lamp. When about a third of the wax was melted, the mercury in the thermometer stood at 70° C. This temperature indicated, therefore, the melting point of the wax. For the determination of the specific gravity two similar pieces of wax were allowed to sink in diluted spirit of wine, contained in a beaker, and distilled water was added, little by little, and mixed well with the spirit until the pieces floated just beneath the surface of the fluid. The specific gravity of this fluid was then determined. This was 0·962, which was taken as the gravity of the wax under examination.

In the further examination 1 gram was warmed with 10 grams of chloriform in a small flask. The solution was clear and yellow, but soon became turbid on cooling, and an almost transparent, colorless, serous mass separated, more particularly upon the walls of the flask. Afterwards 1 gram was dissolved in 15 grams of 70 per cent. alcohol by boiling, and allowed to cool. In the clear yellow-colored solution round and half-round colorless granules were deposited. These were recovered by filtration, dried in the air and weighed; six decigrams were thus obtained. The specific gravity of these granules was 0·910. The filtrate was evaporated at a gentle heat, and left as residue a brittle resin of a beautiful dark-yellow color, weighing about four decigrams. Further, one gram of the wax in raspings was boiled, and well shaken in a solution of 1·4 gram borax in 20 grams of distilled water. A colorless mass separated on the surface of the liquid in the vessel. The liquid was turbid, but on cooling was neither milky nor gelatinous; Japan wax was therefore not present. The same experiment was made with the granules free from resin. This time the fluid remained clear during boiling and when cooled. The granules united into a cake at the top of the fluid. A sample in fine shavings was then agitated with diluted ammonia solution; a portion of the residue above mentioned, free from resin, was also treated with ammonia. In both cases the fluid remained clear and transparent, and the samples unchanged, indicating the absence not only of stearin, but also of curcumin and olein. The granular body quite free from resin, which, according to the above tests, contained neither stearin nor Japan wax, was now tested for paraffin. It had a lustrous appearance and alabaster-like transparency, yielded between the fingers without adhering, and dissolved easily and completely in oil of turpentine and benzin, but not at all in five parts of absolute alcohol.

The examination carried out and described as above should be clearly understood to set up a claim to be exact and exhaustive. It shows the object to be determined, viz., that this product bought and sold for beeswax was no other than a mixture of about 60 per cent. of paraffin and 40 per cent. of common resin, run into cakes, and thinly covered with genuine beeswax. The examination shows also that the specific gravity alone is not sufficient for the detection of adulteration in wax, and that a product perfectly corresponding in this respect with genuine waxmay nevertheless be entirely factitious and useless.—*The Chem. and Drug.*

VANADIUM ANILINE BLACK.

For dyeing aniline black Guyard recommends the following process, premising that for cotton the quantity of the salt of aniline may be diminished, and for wool may even be doubled. The standard dye-beck will consist of:

Water..........................	35 fluid ozs.
Muriate of aniline.....................	2½ ozs.
Chlorate of potash	1¼ to 1⅝ oz.
Chloride of vanadium................	1¼ grain.

In this we steep the yarns or cloth, well prepared, which merely signifies perfectly freed from fatty matter. They are completely and uniformly saturated with the mixture, and are then hung out in well-aired oxidizing chambers, kept at a temperature of 59° to 68° F. The heat is then raised to 95° to 104° F., and is kept up until the goods are perfectly dry. If the black has acquired the desired tone and intensity, they are taken through a beck of bichromate of potash, 150 grains per 35 fluid ozs. of water, dried again, and washed with soap and water. If the black is not intense enough, the goods, after drying and washing, but, before chroming, may be steeped once or twice more in the beck above mentioned, aging after each immersion. The chrome counteracts the slightly greenish tint of the aniline black.

*Pharm. Post, July 1, 1876, p. 218.

FRENCH WORSTED MANUFACTURE.

Last year Mr. J. N. Godwin, J.P., and Mr. Henry Illingworth, gentlemen well versed in the Bradford trade, proceeded to France, on the invitation of the Bradford Chamber of Commerce, of England, for the purpose of investigating the circumstances under which the French manufacturers carried on their business. The report prepared by these gentlemen was lately read at the soirée of the Bradford Chamber. After a few preliminary observations, the report went on as follows:

Our nomination as delegates having proceeded from the Bradford Chamber of Commerce, we have much pleasure in presenting to this Chamber the following general report. A special report, with the requisite detail of figures, we propose to go over carefully with the Tariff Committee as soon as it is formed, and then to place it in the hands, on behalf of the West Riding Association and the Associated Chambers, of those who may have to represent the trade of Bradford and the worsted district in the approaching negotiation for the renewal of the French Treaty. The first step was to follow the example of Messrs. Balsan & Duval, and prepare a questionnaire. This was carefully done by a committee of the Council, and, with the assistance of M. Warnier, late deputy for Reims, translated into French, and printed. We proceeded to Reims, and afterwards to St. Quentin, Roubaix, and Turconing, and then separated—one going to Amiens, and the other to Fourmies, Wignehies, and Le Catteau. Lord Lyons manifested great interest in the important question of the treaty, and the introductions given by M. Teisserenc de Bort were exceedingly cordial.

It is well known that the factory hours are 72 per week in France, and 56½ in England; or, in other words, the French work 27½ per cent. longer than we do, and in some cases earn as little, or less, wages for the longer time.

The worsted manufacture of France is a trade of such vast extent, spread over so large a part of France north of Paris, so solidly established, so wonderfully increased and still evidently increasing, so admirably organized, worked with such skill, intelligence, and industry on the part of all concerned, such a minute attention to detail, and an aim at perfection in every process, as account for and justify its remarkable success, and cannot but render France a formidable competitor. Is it possible, under such circumstances, that she can require protection in any branch of the worsted trade in which she chooses seriously to engage? It may not be out of place here to refer to a few notes which are not within the strict limits of our instructions, but have a collateral and general interest for this district. Establishments for testing condition and measure are in operation on a scale corresponding with the trade of the district—at Fourmies, at Reims, and at Roubaix—but do not exist at St. Quentin. Parties are not compelled to send goods there; but when either buyer or seller wishes it, or a dispute arises, both parties are bound to accept the decision. The pieces are perched, every defect marked, and a deduction of length made for it, and they are then measured.

TESTING THE YARN.

Yarn and wool not greasy may be, but all tops must be, tested. This is done by passing a current of hot air through a cylinder at a temperature of 105° to 115° Centigrade—yarn at a temperature of 105°. A delicately adjusted balance under glass at the top of the cylinder, which indicates to a fraction of a grain, marks the weight of the contents on their introduction, and when it ceases to alter, the loss of weight is noted, and the percentage taken. By law 17 per cent., but 18½ by custom, is the degree of humidity, as compared with absolute dryness, which is allowed.

EDUCATION OF THE OPERATIVES.

We found everywhere a growing desire on the part of the workmen to obtain education for their children, and an anxiety on the part of the masters and the municipalities to furnish it, more especially technical education. In Roubaix, with 80,000 inhabitants, gratuitous instruction, chiefly primary, costs the town £14,000 a year, and they are now building schools for 8,000 children. There are courses of instruction in music, drawing, architectural design, chemistry, and physics, and they are about to establish, on an extensive scale, a school for technical education. At Reims, the Société Industrielle, which had been previously in operation, acquired their present premises at a cost of £4,000, raised by voluntary subscriptions. Each member of the society subscribes £4 a year, and some assistance is received from the municipality. Books are lent from the library, and no losses are said to occur. There is a good room for collections of minerals, crytals, etc.; and a drawing-room for classes, which are held from half-past eight in the evening to half-past nine or ten; for gratuitous instruction in nearly all the subjects (drawing, design, bookkeeping, mechanics, mathematics, etc.) taught in the Ecole Professionelle, a larger and more recent institution. They have also a power-loom and Jacquard for explanation, and a course of weaving by hand, in which were fifty-seven employees and weavers, who had practice in the pattern loom and instruction on the black board on three evenings in the week. The Ecole Municipale Professionelle is a building of five stories, including basement and attic—the front part nearly sixty yards long by fourteen to fifteen wide, and has two wings of nearly the same length; cost about £20,000, with an annual vote from the municipality amounting at present to £1,400, and is managed by a committee outside of the Corporation designated by the Mayor. Young men sufficiently qualified by primary education are admitted for three years, from the age of thirteen to sixteen, during which their aptitudes may be discovered and their tastes developed as a preparation for apprenticeship.

PRACTICAL SCIENCE.

The basement contains the workshops until they can be transferred to one of the wings. In the blacksmith's shop were two forges, and fifteen pupils of the second year at work, under a foreman, welding, hammering and filing. In the adjoining room two joiners' shops, in which were ten pupils under foremen, planing, sawing, turning, and making chairs, etc., for the school. Above these are class-rooms, hung with Achille Comte's very beautiful mural plates, and rooms with cases of instruments and models in optics, acoustics, anatomy, heat, hydrostatics, dynamics, electricity, pneumatics, minerals, etc.; models of steam engines, with glass cylinders and condensers, so that the working could be seen; and a series of mathematical forms, made by the pupils of last year. There is a splendid room for drawing, with models and drawings, a room for oil-painting, and of plaster casts, and for weaving plain and Jacquard. But the department that struck us most was that for chemistry and dyeing, which comprised a class-room to seat 200, a large and very complete laboratory, a second smaller, a third larger, for experiments, and a fourth for chemical stores. Next year yarn goods and wool will be bought, and No. 4 will be appropriated to dyeing. The pupils pay £4 a year, were last year 57 in number; this year 95; and are expected to reach 250 or 300 shortly, and are in the workshops from 7 A.M. to 7 P.M. every day.

We must notice, in conclusion, two other institutions, which appear to give great and general satisfaction. One of these is the Conseil de Prudhommes, composed of masters and men, for the settlement of all disputes between masters and men, with an appeal to the Tribunals of Commerce, before which advocates are allowed. At Roubaix, last year, 1,300 cases came before it, nearly 600 of which were conciliated. The other is the Tribunal of Commerce, composed of a president, three other titular and four assistant judges, all unpaid, and assisted by a registrar. The judges hold office for four years, and are chosen by the list of *commerçans notables*, who number in the Reims district probably 800 or 900. Three judges must sit at once, and they are guided by the Code de Commerce. If there is no appearance judgment goes by default, with a right of appeal. The plaintiff appears in person, or by his advocate. The defendant in like manner replies; the Court asks any questions, retires, and decides, and up to £60 there is no appeal. In the Roubaix Court above 600 suits were entered last year, and in the Reims Court a still larger number. The costs are very small, there is no delay, and on these grounds, as well as from their being courts of equity rather than of law, in which cases are determined chiefly, if not solely, on their merits, these courts are said to be preferred, both by advocates and suitors, to the higher courts.

CLEANING OF WOOLS.

WOOL SCOURING.

The detergents used are, soft soap for fine long wools; and for short wools, both coarse and fine, urine alone, or urine and soda ash or soda ash alone, silicate of soda, and various mixtures of alkaline carbonates and soaps.

The best temperature for the scouring of loose wool is from 125° to 135° F.

The old-fashioned mode of scouring wool, and which gives fair results, is to work it about in a kettle or tub, containing the scouring liquid, with a stick or stang, for five or ten minutes, and then lift it out upon a scray, with the stang or a fork, by small portions at a time. When it has drained upon the scray, it is then thrown into a cistern called a "wash-off," the bottom of which is fitted with perforated iron plates. Water is then run into the cistern by a five or six inch pipe entering horizontally, and when full the wool is stirred up well in it. The water is then let out from under the perforated plates by means of a clack. The washing with water is repeated two or three times. This method requires an abundant supply of water, but is, in other respects, economical. An improvement upon this process, very often resorted to, is to have a perforated sheet iron shell swung on a trunnion, and fixed to a crane. The shell is lowered down into the scouring pan, and the wool scoured in it; when ready it is drawn out by the crane and the wool thrown out into the wash-off cistern by tilting the shell over. The wool is washed two or three times as before. One man can scour from 500 lbs. to 600 lbs. per day by the first mode; it requires two men to scour by the perforated shell, but more work can be got through.

For certain classes of wool, in which soap is employed as the detergent, the scoured wool is passed between rollers instead of washing it.

Long stapled wools are manipulated with forks by hand in the scouring fluid.

In most large factories, however, the above processes for cleansing wool from their natural impurities have been superseded by the introduction of wool-scouring machines, the first of which was invented in 1851 by Mr. John Petre, Jr., of Rochdale, who has since that time very greatly improved the machine; in fact, the latest form of it, the "Paragon," as he calls it, leaves little to be desired.

A complete machine consists of three boxes or bowls. The wool is fed into the first by a boy. In this bowl a strong scour is placed, through which the wool is forked by forks ingeniously fixed to cranks; from this bowl it is passed through rollers into the second, which contains a weaker scour; it then passes through rollers to the third, in which it is forked through running water; and lastly passes between heavy squeezing rollers, and is thrown forward by a powerful fan, which leaves it light and open. The wool is turned out very clean and half dry. In fact, the machine performs a large amount of work in a very satisfactory manner, and the manufacturers who use them tell me that they are very much pleased with them. McNaught's and Leech's machines, each possessing special features of their own, are also spoken well of by those who use them.

YARN SCOURING.

The impurities to be removed by scouring from woolen yarn are, oil which has been used to enable the wool to be scribbled and spun, and accumulated dirt. The detergent used is a mixture of soap and ammonia, but for some descriptions of yarns cheaper alkaline liquids may be used.

It is important that the felting of the yarn should be avoided as much as possible. This may be accomplished by steeping the yarn in hot water, and leaving it to cool before scouring.

The scouring is done in a wood cistern filled with the scouring fluid; the yarn is hung on sticks placed across the cistern, it is turned over frequently, and worked about in the scour, and finally wrung out. The best temperature for the yarn scour is from 140° to 150° F.

CLOTH SCOURING.

This is always done in a machine consisting of a bowl or cistern, and squeezing rollers placed above. The scouring materials vary with the description of cloth, soda ash, soda crystals, and soap ash being usually employed for woolen cloths. The cloth passes through the scouring liquid heated to from 150° to 160° F., and then between the rollers for some time, whereby the oil contained in the cloth is removed in the form of an emulsion by the detergent. The scour is frequently used again, after being strengthened by the addition of more alkali. The cloth is finally washed in clean running water on the machine for a considerable time. The thorough removal of all oil, soap, and grease from the cloth is very important for the subsequent dyeing, for, if any remain in it, the action of the mordant is seriously interfered with.

WOOL BLEACHING.

The mode of bleaching woolen goods in general use at the present day is of a very primitive character, there having been but little improvement in the process since the days of Pompeii, in the ruins of which, Pliny tells us, there were found traces of the art. As in those days, so now, a closed chamber, in which the goods to be bleached are hung up, is filled with the fumes of burning sulphur, and the goods left exposed to the action of these sulphurous fumes for some hours, during which time the yellow coloring matter of the wool is more or less affected, probably by the reducing action of the sulphurous acid, whereby the coloring matter is transformed into a colorless substance. The bleaching, however, is not of a very permanent character, the color being liable to return, especially if the goods are treated with alkaline solutions, which frequently favor oxidation. The bleaching of wool with sulphurous acid is, therefore, not so satisfactory as the bleaching of cotton with chlorine.

Chlorine is not suitable for the bleaching of wool, for it attacks and damages the fibre, without bleaching it. Sulphurous acid is the only bleaching agent which has proved effective for wool. The operation is called sulphuring, or stoving. The sulphur stove is built of brick or stone, and often lined with wood, as few nails as possible being used, to prevent damage from sulphate of iron, which is formed by the sulphurous acid, combined with air, acting upon the nails. The goods to be bleached are well soaped and washed, and, while in a moist condition, are hung up in the room. A quantity of sulphur is placed in an iron dish in the room, and a red-hot piece of iron is dropped among it; the door is then closed, and the room left undisturbed for some hours. The door is then thrown open, and the sulphurous acid gas escapes; the goods are then removed and washed, to free them from the sulphurous acid, which, if left in contact with the fibre, would become sulphuric acid by the oxidizing action of the air.

Certain improvements have been suggested in the management of these sulphur chambers, having for their object economy in the use of sulphur; the more equal diffusion of sulphurous acid in the chamber, and, consequently, more regularity in its action; and, lastly, prevention of the destructive action on vegetation arising from the escape of the sulphurous acid on opening the door. In the *Moniteur de la Teinture* for 1872, an arrangement is described which is likely to accomplish this object. Sulphurous acid, produced in a sulphur burner, is forced into the chamber by means of a small steam jet, and when the goods have been exposed in the room for the proper time the sulphurous acid is drawn out by an aspirator, and is absorbed by carbonate of soda, which it converts into sulphate of soda. An additional improvement consists of an arrangement for passing the goods through the chamber by means of rollers. The bleaching of cloth can thus be made continuous.—*Textile Manufacturer.*

SCHOOL OF WEAVING.

The Chamber of Commerce of Lyons, naturally proud of the exquisite fabrics of the city, and desirous that they should be still further improved, gave a sum of ten thousand dollars for the establishment of a weaving section in the School of Commerce of the city; and the other day the members paid a visit to the school to see what progress had been made.

The section was only formed six months since, but it assumed considerable importance immediately.

The weaving school is established in a special building, of three stories; it possesses at present 14 looms. On the upper floor are plain looms for satin, pekin, faille and velvet, with a lecture room, and cabinet for demonstrations. On the first floor, looms for fancy tissues, brilliantine, embroidery, damask, gauze, fancy velvets; Saint Etienne looms for ribbons; and a room for reading designs. On the ground floor are power looms by Dièderiche and Sallier, a double-width plain velvet loom, both driven by a gas engine of one-horse power, which has the advantage of being started or stopped instantaneously.

There are at present 21 pupils in the section, divided into two classes, and alternately working at the loom and studying the theory of the art. The pupils are also taught bookkeeping, foreign languages, and mechanical drawing. A director and two workmen suffice for the practical work, and there are two professors for the theoretical.

The establishment of such a school has often been pressed upon Lyons, but, heretofore, the authorities have hesitated to take the initiative; having done so, the success was immediate, and the act most popular.

In the report on the subject occurs this paragraph, which well deserves careful consideration in all countries: "In our days, the first thing necessary for the development of an industry is the raising of the instruction of those who are employed in it. Here is the secret of all success. Practice, traditions, usage, all require to be constantly revivified by the teachings of science."

SILK PRINTING.*

The bleaching having been accomplished by treating the goods with hot solution of soap and then sulphuring, the next process is the preparation.

Preparation, or Mordanting.—This operation has for its end the combining of certain metallic elements with the silk, which have the property of developing the coloring matters of the dyewoods used in the colors. The salts of tin are now admitted as possessing this property in the highest degree; they give also more brightness to Prussian blues, and it is a combination of the ferrocyanides of iron with those of tin which produce royal blues, or French blues.

Mordanting with alumina salts for steam colors is at this day entirely abandoned, and we speak only of the tin salts.

In a wooden vat, capable of holding 70 to 80 gallons, dissolve 25 lbs. cream of tartar, 7½ lbs. of bichloride of tin. Raise the temperature of the whole to between 120° and 140° F., by means of a leaden steam pipe; copper steam piping must be avoided, for it causes the production of black stains upon the stuff which cannot be removed. About 300 foulards at a time can be placed in this solution, in which they must be regularly moved about by means of a wince for the space of an hour; they are then drained upon a stillage placed higher than the vat; afterwards washed and evenly dried upon steam drums, which is preferable to hanging them up to dry, since in the latter way it is difficult to avoid creases forming in the goods. Goods dried by hanging require to be ironed with a hot iron before printing to take out the creases.

As many as 15,000 to 20,000 foulards may be mordanted in the same vat, but it must be strengthened or freshened up for every 300 fresh foulards with, say, 2 lbs. of cream of tartar, 1¼ to 1½ lbs. of bichloride of tin, keeping up the quantity of water to the original level.

*From the work of M. D. Kæppelin.

This preparing liquor should mark from 4° to 5° Tw., and must throughout be kept up to this strength by adding salts in the proportions indicated, more or less as may be required, but not departing from the relative quantities of tartar and tin solution.

Upon the proper management of this preparation depends in a great degree the success of the after processes.

When the foulards are to have a white ground or a light colored ground, the preparation should be done cold, *i.e.*, at about 60° to 70° F. In this case the foulards are simply immersed in the tin and tartar solution for four or five hours, moving them now and then, so as to insure an equal degree of contact with the liquor.

For goods which are to have dark blue and dark green grounds, and also browns and blacks, the temperature of the preparation must be raised to 140°. By employing this higher temperature more tin is fixed upon the stuff, and the colors are obtained fuller and brighter. Those foulards which are intended for fine and fancy designs, and which must have a perfectly white ground, are not mordanted at all before printing

It sometimes happens after the mordanting bath has been in use for a time that it becomes turbid, and deposits oxide of tin; in this case the clear liquor must be drawn off, and the vat well cleaned out, for it is an indispenable point to have the liquor quite clear and transparent.

Printing.—The process of printing by block does not call for much explanation, as it is carried on in nearly the same manner as in printing calico or woolens. It is the practice in some places to use a piece of calico between the silk and the table blanket which travels on with the printed piece; in others the blanket is covered by a piece of waxed or waterproof cloth, so that the colors pressed through the silk may not soil the blanket. The calico piece, though more costly, gives the best results, and is especially to be preferred when the printing room is in a low or damp place, as it is more effectual in not preventing the colors running when they do not dry quickly enough, and also the possibility of "marking off."

In printing a design of several colors by block, the printer first puts on the black or brown, which serves for boundage; next the dark green, red, the dark purple, the dark wood colors, and the light blue; that is, all the dark colors, the light blue being an exception, it being printed before the dark. Afterwards the simpler bright colors are printed, then the paler colors, such as pink, violet, green, light wood shades; then the dark blue. The ground color is put on last.

To obtain a full color in the grounds and the strongest parts of the design, the black is applied twice in those places.

With regard to the sieve cloths used to furnish color to the blocks, experience dictates the following treatment: those in use for light shades should be washed every two days; those serving for orange made from Persian berries, as well as those for royal blue, should be washed every day. The sieve cloths in use for red and black should never be washed. These colors are better and fuller when furnished by a cloth which has been in use for a considerable time, and is well saturated with color. When it is necessary to replace the old cloths, the new ones should be well saturated with color, and not put into use until they have been soaked with it for two days. The same precaution should be observed with regard to the sieve cloths for browns, dark purples, and dark greens; they should not be washed more than once a month, and should be prepared for use two days before they are wanted.

The tables for printing silk warps for producing chené silks are from 13 to 16 yards long, and provided with combs or reeds and rollers, to keep the warp in a proper position, and all the threads as much as possible in the same state of tension. This printing requires peculiar care and skill to secure good results, as also the subsequent operations of fixing the colors and drying the warps, for, as it is known, these go back to the weaver, who then puts in the weft. The effect produced by the weft threads partly hiding the colored warp, is to show the design with a peculiar broken, softened, and altogether novel aspect. When it is intended to weave in transverse stripes of satin or velvet in the silk, spaces are reserved for that purpose before printing, and very rich effects may be obtained.

In marine printing, whether by plate, Perrotine, or ordinary roller, the same colors may be used as with block, with slight changes, care must be taken that the drying apparatus is kept at a much lower temperature than for other goods; in fact, if the silk is heated beyond 90° F., the acids and acid salts which are present in the colors injure the tissue. The greatest care, therefore, must be bestowed upon this point, but still the colors must be dried rapidly enough to prevent any chance of their running; the printer must attend closely to the drying of the goods.

Lithographic printing in one or several colors is somewhat extensively employed on silk handkerchiefs. The colors employed would appear to be of the pigment class, and fixed by oil or varnish.

Fixing or Steaming.—The steaming is effected either by suspending the goods in a box or vat into which steam is admitted, or else by the system known as the column of tins. The first method may be varied, and adapted to any of the known methods of construction of steaming houses or cottages. The plan much used abroad consists essentially in a wooden vat, square or circular, set with its opening upwards; steam is admitted at the bottom; and goods, fixed on a frame, are lowered into it by rope and pulley; the opening is closed and the requisite amount of pressure got up; the usual precautions must be taken to prevent wetting by drops of water or condensation of steam upon the fabric itself. The pressure of steam in general is one atmosphere, excepting for red and orange grounds, when it ought not to exceed a quarter of an atmosphere.

Foulards with scarlet, orange, and royal blue grounds are steamed twice, being rehooked upon the frame and reversed; fresh grays are employed each time. The first steaming lasts 15 minutes and the second 20 minutes.

All other styles of whatever colors are steamed at one operation, allowing them to remain forty-five minutes in the steam.

The steaming by column or tin cylinder is not so certain and regular in its results, and should not be adopted if the means of open steaming are available.

Washing.—The pieces should be first immersed in running water and left until the thickening of the colors is well softened, and then gently rinsed until all the loose or unfixed color has been detached and carried away by the stream. A light beating in a machine, or wincing, is sometimes necessary to get the cloth quite clean. An end of the piece being wrung in the hand should not yield any color after the washing.

The excess of water is expelled by the hydro-extractor, and the pieces are then dried, either over the drying tins or by hanging up in a warm room.

Bluing.—The parts not printed upon, and which should be white, are always found to be somewhat tinged by the operations of steaming and washing; it is necessary, therefore, to remedy this defect as far as possible, and for that purpose the pieces are passed full width in a box fitted up with rollers, through water mixed with solutions of ammoniacal cochineal and sulphate of indigo. Sufficient of these two colors is added to give a fine purple color to the water, but the actual quantity necessary has to be regulated according to the particular circumstances, and can only be learned by experience. A sample of the proper white wanted is kept at hand in a moist state and compared with the goods from time to time, and the strength of the bluing liquid altered as may be required to produce the proper tinge.

Finishing.—The foulards are impregnated either by hand with a sponge or by a padding machine, with a mucilage of gum tragacanth (1¼ lbs. gum to 6 gallons of water), to which is added a minute proportion of bichloride of tin to commucate a crisp feel to the silk.

The damp pieces are then rapidly dried by passing over heated metal cylinders, and subjected to pressure in a hydraulic press as follows: They are folded with glazed pasteboard in such a way that a piece of cardboard is between each fold of silk; at the tenth piece of cardboard a plate of cast iron, previously heated to a considerable temperature, is introduced, and the piling continued in that way until the mass is about five feet high; the whole is then submitted to hydraulic pressure for ten hours with such a force that the heap is reduced to two-thirds of its original height.

For silk to be dyed in madder the bichloride of tin must not be added, and the metallic drying cylinder is covered with fine calico to protect the red color from injury by too sharp a heat.

Styles with dark grounds, or those dyed in blue, should have a thinner solution of gum tragacanth than others, because it covers and takes away from the beauty of the colors. For such styles a finishing fluid is used which contains but little or no tragacanth, made with rice water, to which some fish glue or isinglass may be added.

Madder-dyed silks are best finished or dried upon a frame; to effect this they are taken in the wet state and hooked upon a framework long enough for a piece of seven foulards, the piece then dries perfectly even and brilliant. This method is preferable to that of hot drying, because it does not dull the madder colors, and gives the silk more elasticity and softness.

Mordants and Various Preparations.—Acetate of alumina, at 10° Tw.; alum, 70 lbs.; water, 20 gallons; and acetate of lead, 60 lbs. Put the alum, well broken up, into a wooden tub which can hold 30 gallons, then pour upon it the 20 gallons of water at a boiling heat, stir up with a wooden spade until it is dissolved, and add the acetate of lead, keep stirring for half an hour, so as to secure thorough decomposition of the salts.

BELGIAN PROCESS FOR BLEACHING LINEN AND COTTON (1,100 POUNDS).

DISSOLVE 22 lbs. carbonate of soda in water, and add the same weight of quicklime, previously slaked. Draw off the clear, and boil the goods in this for an hour, rinse, and take through spirits of salts at 2° B., and rinse again. Then bleach in a solution of 11 lbs. chloride of lime for 5 to 6 hours. Take again through spirits of salts at 2° B. Rinse well, and blue in a beck of 5½ lbs. of soap, with the necessary quantity of ultramarine.—*Le Teinturier Pratique.*

MIXED GOODS.

IF cotton tissues are padded in a solution of eosine thickened with gum, and then, after dyeing, steeped in a solution of acetate of lead, they become coated with a very brilliant coating of red lake, very suitable for artificial flowers and other fancy uses. In case of mixed goods with a cotton warp, the wool or waste is first prepared in a hot alum beck, and the cotton is then mordanted as above directed. The goods are then dyed at a hand heat. At a boil the color is thrown chiefly upon the wool, and the heat employed is therefore a means for causing the color to take evenly upon the two fibres.

IODINE, OR METHYL GREEN, FOR PRINTING ON COTTON.

MIX together, according to shade desired, a solution of 15 to 40 grammes of methyl green with 70 grammes of oxalic acid, and 150 grammes of tannin, and a little acetic acid, and add ½ kilo. of this dye solution to the thickening solution. composed of 1 part of solution of dextrine, and 3 parts of gum tragacanth, and 2 parts of water, as well as 100 grammes of starch.—*Muster Zeitung.*

METHYL GREEN ON COTTON.

TO OBTAIN a good full shade with methyl green on cotton, without waste of dye materials, work as follows: Impregnate the cotton with a solution of soap, then pass through a weak solution of chloride of lime. Wash, and then mordant with a solution of tannin, as is usual in dyeing ordinary aniline colors on cotton. After this, dye in a weak solution of methyl green, then immerse in a weak bath of picric acid, and again in methyl green, until you get the desired shade. If well managed, this green is very fast.—*Muster Zeitung.*

DARK YELLOW-BROWN ON COTTON AND MIXED GOODS.

THIS brown is very fast, and can easily be produced by the following method: Boil together 3½ lbs. catechu, and 6 ounces of sulphate of copper; after cooling, use this solution for dyeing 22 lbs. of the goods. Immerse, cool, and gradually heat to boiling point, and work for three-quarters of an hour. When cool (but not washed) pass through a solution of 8 ounces of bichrome, and finally darken with logwood, and, if a deep, dark shade is required, pass through a weak solution of iron, then wash off.—*Muster Zeitung.*

THE TRANSFER OF PATTERN DESIGNS.

TO EFFECT the transfer of pattern designs on copper plates, or copper rollers, as well as on steel mills, the following method is recommended by G. Witz, in the *Bulletin de Rouen*, as introduced in the print works of Barcelona, etc.: The pattern of the designer is first traced on straw or flax paper, by drawing it in outline by means of a brush or a crow's quill dipped in a solution of red iodide of mercury, white lead, and gum water. As soon as this tracing is dry, the paper is fastened down at its four corners on to the copper-plate roller, or mill, by means of wax, care being taken that the metal plate or roller is perfectly clean and free of any greasy places; ordinary paper is next laid over the tracing paper, and moderate pressure applied to the whole drawn surface. If it be intended to transfer direct to the actual printing roller, then the flax paper is first unlapped in a spiral fashion with a piece of well calendered and stiffly held calico fastened to the printing roller. After a lapse of several hours—twelve hours at the utmost—the tracing paper is again removed from the metal surface, upon which faint lines may be seen corresponding to the tracing, through the action of the iodide of mercury on the metal. If the plate, roller, or mill be exposed to the atmosphere during several days, these faint lines develop themselves into clearly perceptible, more or less dark gray lines, which cannot be removed by rubbing with the moist or dry hand, and which, consequently, the hand of the engraver cannot obliterate. Moreover, if such a tracing on flax paper be kept from the sun's rays—*i. e.*, light—very clear metal impressions may be obtained from the same drawing after several months.

The simple iodide of mercury tracing ink is prepared in the usual manner, by adding to a solution of 40 grs. sublimate in ¼ litre of water, a solution of 50 grs. iodide of potassium mixed in the same quantity of water. A residue of 60 grs. is obtained, which is washed with water and dried, after filtering under the exclusion of light.

NEW SIZE.

HAI-THAO, or gelose, is a tasteless, odorless, colorless mass, obtained from a fibrous seaweed common on the coast of China and Mauritius. It is insoluble in cold water, but dissolves in hot water after boiling for ten minutes, and then forms a thin, dirty white solution, which, on cooling, deposits a yellowish-gray jelly. The material has lately been used on the continent for finishing cotton fabrics, and is reported to fill the thread more perfectly than dextrine or starch. By adding glycerine to the hai-thao solution, a still softer and at the same time stronger material is obtained. According to experiments made by Heilmann, an abstract of which is given in Dingler's *Polytechnisches Journal*, it appears that the material can only be employed for fine textures, soft and firm to the touch, and cannot be used as a substitute for dextrine or potato starch where a strong material is required.

KERAMIC ART.

PROFESSOR ARCHER lately delivered a lecture on Keramic Art at Edinburgh, in the Museum of Science and Art. After mentioning, in the outset, that, at the end of the Roman period, European pottery shared in the general decadence of artistic feeling, the lecturer went on to say that in the early part of the thirteenth century the Moors introduced into Spain a superior kind of work, of which some wonderful examples were found in the mural tiles of the Alhambra and other palaces. On the expulsion of the military class of Moors many of the industrial class were retained, or emigrated to the Balearic Isles, where they produced the pottery which was called by the Italians Majolica, from the name of the principal island. The manufacture was by and by transferred to Italy, where, in the 15th century, Luca Della Robbia improved the glaze and various points of the coloring. He was succeeded by a great school of painters on pottery, made in the general style of majolica, and their works continued the name, which was now applied by collectors to Italian faïence, having a coating of a peculiar glaze, on which the decoration was painted in opaque color, and over which no other glaze was afterwards put. Very like the majolica in many respects was the Persian and Rhodian faïence, in which floral decoration was used to a very large extent, and of which it used to be held that where red appeared among the colors the ware was made in Rhodes. The Arabs and Moors strove to produce beautiful mural tiles; but no people had surpassed the Persians in this kind of work. Their colors were harmonious in themselves and harmoniously arranged, and the glaze of the finest quality. Coming to the more modern manufacture, Professor Archer pointed out the difference between simple baked clay and that in which the firing fuses the materials together; and explained the nature of the pure clay known as kaolin, which is suitable for the manufacture of the finest wares. Reference was made to the extensive production of kaolin in Cornwall and Devonshire; and it was mentioned that the material has been discovered of high quality and in great abundance in some parts of the United States, and that, in order to cope with a strike among the Cornish clay workers, the Minton firm proposed to import it from that quarter. Proceeding to classify the various kinds of ware, the lecturer mentioned, first, pottery, in which the body was common clay, and which was glazed by dipping into a mixture of powdered glass, afterwards to be fused in the furnace; secondly, stoneware, formed of clay in which a considerable amount of silica was mixed, and which was glazed by throwing salt into the furnace; thirdly, stone-china, in which pipeclay was combined with a large amount of silica, so as to produce an exceedingly hard ware; and lastly, porcelain, the chief ingredient of which was the kaolin, produced by the decomposition of felspathic rocks, phosphate of lime being added in the form of calcined bones to give softness. Touching briefly on the varieties of European pottery, the Professor specified, first, the French faïence. Of this a most remarkable variety, named Henri Deux, was produced between 1520 and 1550. There were only twenty-six pieces of it in England, which were valued at £16,340. In France there were also twenty-six, but these being of less importance, were only valued at £2,250; and the only other piece known was in Russia, and was valued at £800. Another remarkable kind of French pottery was that produced by Palissy. The Dutch, again, concealing the defects of their clay with a fine white glaze, produced the popular Delft ware, of which some beautiful varieties were also turned out by the French at Rouen and other places. To Germany specially belonged the stoneware which had been so successfully revived of late years by Doulton, of Lambeth. The Staffordshire ware was at one time the lowest in point of art to be found anywhere, but the manufacture received an impulse from Wedgewood, who brought out the marvelous ironstone china. He was greatly aided by Flaxman, the sculptor, who co-operated in the construction of the Wedgewood vase. Of this fifty copies were produced; the last sold realized £206, and they were still rising in the market. At the present moment the largest pottery in the world was that of Minton, in Staffordshire, where, however, for the decorative part of the work, French artists were largely employed. Professor Archer concluded, with some remarks on the civilizing influence of beautiful pottery, a lecture which had been illustrated throughout by means of models and specimens of ware, and had been listened to with appreciative attention.—*Building News.*

CHEAP GREENHOUSES—HOW TO HEAT THEM.

By PETER HENDERSON.

FIG. 1 shows three of the usual ridge and furrow houses, which are 60 feet long and 11 feet wide, each with a furnace room, or shed, at one end, which is 12×33 feet. Of course the length may be increased or diminished as desired, but this width is found to be the most convenient. It will be seen that the three greenhouses are heated by *two* furnaces, the flue being so disposed under the center benches of the houses as not to cross any of the pathways. This gives, of course, two runs of the flue to the middle house, and only one run each to the outside houses. This would in coldest weather give a temperature of not less than 40° to the outside houses, and 60° or 65° to the middle house, which has the two runs of flues. This difference in temperature is indispensable in a general collection of plants, and the neglect of it is more than anything else the cause of failure where growers have but one greenhouse. It will be necessary to have the flues built as close to the walks as possible, so that the heat be evenly distributed in the two outside houses. Fig. 2 shows a greenhouse 20 feet wide by 60 feet long, with furnace room or shed 12×20 feet. Here again the flues are so disposed as to avoid crossing the walks, being placed under the center bench, but as near as possible to the walk on each side, so that the heat may be evenly diffused throughout. If a difference in temperature is required in a house of this kind, it may be obtained by running a glass partition *across* the house, say at 25 feet from the furnace end, which will, of course, make that end the hottest. The flue, in each case, runs back to the furnace from which it starts and into the chimney, which is built on the top of the furnace. As soon as a fire is lighted in the furnace, the brick-work forming the arch gets heated, and at once starts an upward draft, which puts the smoke-flue into immediate action and maintains it; hence there is never any trouble about the draft as in ordinary flues having the chimney at the most distant point from the furnace. It will be seen that by this plan we not only get rid of the violent heat given out by the furnace, but at the same time it insures a complete draft, so that the heated air from the furnace being rapidly carried through the entire length of the flue, is nearly as hot when it enters the chimney as when it left the furnace.

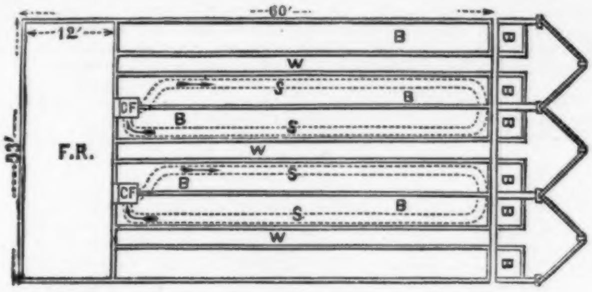


FIG. 1.—PLAN OF THREE HOUSES COMBINED.—Length, 60 ft.; width, 33 ft.

F, R, Furnace Room, 12×33 ft.; B, B, Benches, 4½ ft. wide; W, W, Walks, 2 ft. wide; S, S, Smoke-flue for heating; F, C, Furnace, with Chimney built on top of it.

This perfect draft also does away with all danger of the escape of gas from the flues into the greenhouse, which often happens when the draft is not active. Although no system of heating by smoke-flues is so satisfactory as by hot water, yet there are hundreds who have neither the means nor inclination to go to the greater expense of hot water heating, and to such this revived method is one that will, to a great extent, simplify and cheapen the erection of greenhouses. Many old-established florists, who have had the old plan of flues in use, have changed them to the one here described, and with great satisfaction. The wonder is that such an important fact has been so long overlooked, for when at the time it was discovered, heating greenhouses by flues was almost the only method in use. As some may desire to know the cost of structures like those above described, I would say that, at present prices in the vicinity of New York, the plan of Fig. 1 would cost, complete, about $8 per running foot, or about $600 for the whole building, 72×33. The house shown in Fig. 2 would cost about $7 per running foot, or about $500 for the 72×20. This price is only for plain substantial work, such as is put up by commercial florists. The side and end walls being made of wood in the usual way, with cedar or chestnut posts (locust is more durable than either), and double boarded, with a layer of tarred paper between.—*American Agriculturalist.*

DISCOVERY OF A REMEDY FOR THE GRAPE-VINE DISEASE.

SOME time ago we published in our columns a short account of the results of the investigations of various scientific men in France into the nature of the Phylloxera—that terrible scourge which is committing such wide-spread ravages among the French vineyards. Latterly we have received some reports communicated to the French Academy of Sciences, dealing with the attempts which have been made during the last three or four years to arrest the mischief done by the insect, and ultimately to destroy it altogether by means of some potent drug. It is obvious that the remedy to be employed must possess two qualities at starting, viz., it must destroy the insect and it must not damage to any great extent the vine. But, further, it is not sufficient that when put in close contact with the roots of a plant—as in a pot—it should prove fatal to the insect, it is necessary, if the remedy is to be of real practical value, that it should reach and destroy the Phylloxera on all the parts attacked by it in vines which are planted out in the open air. This is a real difficulty to overcome, as the remedy, be it in the form of solution or of vapor, cannot easily permeate the soil, sometimes clayey, sometimes sandy, on which the vine is growing, so as to reach and act upon the smaller root branches whose nutrition the Phylloxera diverts into itself.

M. Mouillefert, a professor at the School of Agriculture at Grignon, was the gentleman delegated by the Academy of Sciences to make the necessary experiments for the purpose of determining what agent was the most practically applicable to the destruction of the Phylloxera, and the account of the numerous substances employed by him with varying results fills no less than 200 pages of a memoir presented to the Academy of Sciences. It is not our intention here to do more than give a brief *résumé* of the results at which he arrived.

He divides the substances used by him into seven groups, the first of which was composed of manures of various kinds, such as guano, superphosphates, farm muck, etc.; the second of neutral substances, as water, soot, and sand; the third of alkalies, as ammonia and soda, the fourth of saline products, amongst which were the sulphates of iron, copper, zinc, potassium, and ammonia, alum, and sea salt; the fifth of vegetable essences and products, as decoctions of hemp, datura, absinthe, valerian, and tobacco; the sixth of empyreumatic products; and the seventh of sulphur compounds. It was only with some of the substances contained in this last group that really satisfactory results were obtained, and it is to M. Dumas, the permanent secretary of the French Academy of Sciences, that the credit is due for suggesting the employment of the alkaline sulpho-carbonates of potassium and sodium and those of barium and calcium. All the other classes of remedies, mentioned above, were either without effect on the Phylloxera, or, in destroying it, also destroyed or damaged the vine.

The sulpho-carbonates, which were carefully studied by the great Swedish chemist, Berzelius, are obtained by combining the alkaline mono-sulphides with the bi-sulphide of carbon, are either liquid or solid, and emit a powerful odor of sulphuretted hydrogen and bi-sulphide of carbon.

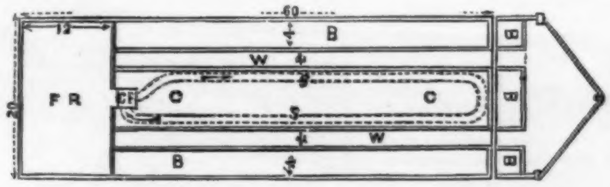


FIG. 2.—PLAN OF A SINGLE HOUSE—60×20 ft.

F, R, Furnace Room, 12×20 ft., B, B, Side Benches, 4 ft. wide; C, C, Center Bench, 5 ft. wide; W, W, Walks, 2 ft. wide; S, S, Smoke-flue; C, F, Furnace, with Chimney above.

The alkaline sulpho-carbonates in the solid state are of a beautiful reddish yellow color and deliquescent, but are not easily obtainable in that condition; the sulpho-carbonate of barium can be easily procured, however, in a solid state, and presents the appearance of a yellow powder, but little soluble in water. The sulpho-carbonates decompose under the influence of carbonic acid, forming a carbonate, and evolving sulphuretted hydrogen and bi-sulphide of carbon. These two latter substances are gradually liberated and, as they have a very powerful effect on the Phylloxera, one can understand that the sulpho-carbonate, placed in the ground, may prove, by its slow decomposition, a powerful insecticide. In the case of the sulpho-carbonate of potassium, over and above its toxic effect, it has a direct invigorating influence upon the vine, as the carbonate of potassium is an excellent manure.

The employment of the sulpho-carbonates as a means for the destruction of the Phylloxera was suggested to M. Dumas by the clearly recognized need that there was of some substance that would evaporate less quickly than the bi-sulphide of carbon: he saw that it was desirable to apply the insecticides in some combination which would fix them and only allow them to evaporate gradually, so that their action might continue long enough in any one place to infect with their vapors all the surrounding soil.

But the task of eradicating the Phylloxera has by no means been accomplished by the mere discovery of the value for the purpose of these substances; there is the further difficulty of applying them to the vine in cultivation. One thing seems very certain that, in order to render the sulpho-carbonates practically efficacious in killing the insect, it is necessary to use water as the vehicle by which they may be brought to all the underground parts of the plant, and that the best time of year for their application is the winter or early spring, when the earth is still moist and the quantity of water necessary to be brought on to the ground by artificial means is consequently less. Mixed with lime in the proportion of 2 to 1, these sulpho-carbonates give a powder which can be spread over the ground before the heavy rains, that is, between October and March, and which will probably prove itself very efficacious.

The conclusion at which M. Mouillefert arrives at the end of his report is that the efficacy of the sulpho-carbonates is proved, and all that is necessary is to bring to perfection their employment in agriculture, which can only be accomplished by the intelligence and practical knowledge of the vine-grower who is well able to discover the economic processes of culture which are conducive to their successful application.

He ends by saying that "Science has accomplished its mission, and it remains for Agriculture to fulfil its part" in the eradication of the Phylloxera from the vineyards of France.—*Nature.*

STRUCTURE OF THE MUSHROOM.

THIS has been explained very fully by Mr. Worthington Smith, F.L.S., in a paper which he read before the Cryptogamic Society of Scotland, and which was illustrated by numerous drawings. He says "that the entire substance of the common mushroom is made up of excessively small bladder-like cells; these cells are so small in size and light of weight that no less than 1,500,000,000,000 (one and a half billion) of cells go to every ounce of the mushroom's weight. Mushrooms are generally grown by dealers from spawn or mycelium; this spawn is nothing but living matted cells in a resting condition, needing warmth, moisture, and darkness only for vivification. Mushrooms may, however, be grown from the purple-black dust which falls from their lower surface. This black dust again simply consists of nothing but cells, but in this case the cells are termed spores. These latter are of a somewhat different nature from the simple cells of flesh of the mushroom, and their outer coat in this species is changed in color from transparent to purple-black, possibly from contact with the air. The cells in the stem of the mushroom are sausage-shaped, and grow vertically; on reaching the cap these cells spread over in an umbrella fashion, and descend into the internal substance of each individual gill. This internal mass of cells within the gill is termed the 'trama' by botanists. To understand how the mushroom produces its seeds or spores, a slice should be cut off the side of the cap of a mushroom from the top downwards. Where the sectional part is now exposed, the gills which are cut through will look like so many small fine teeth of a comb. With a sharp lancet a very small thin transparent fragment must now be sliced off from the top downwards, and placed upon a glass for examination under the microscope. When magnified 250 diameters this fragment will be seen to consist wholly of simple cells. These 'trama' cells are of some importance, because certain members of the mushroom tribe have no longer cells of this nature. As these latter cells gradually grow to the exposed surface on each side of the gill, they get considerably smaller in size, denser and less and less transparent. The exposed surface of the gill is the fruiting, spore-bearing, or hymenial surface. The spores in all the mushroom tribe are produced in clusters of four on each basidium, but on the common mushroom and all its varieties, as far as I have seen, these four spores are generally produced two at a time, and as the first two drop off the last two appear, so that it is seldom that more than two are seen *in situ* at the same time. This phenomenon teaches a valuable lesson, and one which has, as I conceive, been quite erroneously interpreted by Professor Sachs, who says the common mushroom only produces two spores on each basidium, and so illustrates the subject in his Fig. 174. The cells of the mushroom increase in number by apical growth. The last formed cell repeats the process continuously till the fungus is complete and the special cells (spores) destined for the reproduction of the species are reached. The basidium is first a simple cell, seen in two positions. This simple cell becomes potentially (but often indefinitely) divided by a longitudinal partition; each of these divided portions produces a branch, and each of these branches bears a spore, which in its turn is again cut off by cell division, this time transversely. The basidium is now again longitudinally divided; these portions in their turn also produce new branches, which give rise to two more spores, each spore again cut off by a transverse septum. As the two last formed spores increase in size they gradually push the two old ones off their supports, so that unless the whole process is very carefully watched it might be concluded that the mushroom produces only two spores (instead of four) on each basidium, as stated by Professor Sachs.

"The mature spores on germination of course reproduce the species by means of a series of new cells. All experiments prove the life of the spore to be very short, but when the spore once germinates and forms spawn, the latter material has great tenacity of life, and this mycelium is commonly, if not always, perennial."

LOSS OF SHADE TREES IN CITIES.

IN the report on the shade trees of Washington, by Wm. R. Smith, Chairman, and Wm. Saunders, Secretary of the Parking Commission, among the valuable suggestions is this, that where pavements are made of concrete or broad flags, there should be a foot or so of space left along between them and the curb-stone. We have known cases where the pavement completely covers the sidewalk, and the trees become very sickly for want of air to the roots.

In relation to the loss of street trees by coal gas at the roots, the subject is so important that we extract the whole paragraph:

"There is an annual loss of trees, more or less extensive, from leakage in the gas pipes; the escaping gas permeates the soil and destroys the roots. Perfect immunity from this evil is probably impracticable, and when detected it may be, as in most instances in this city it has been, promptly remedied. The worst feature, however, is that the evil is not discovered until after the roots have been destroyed or fatally injured; the soil is well saturated before the presence of escaping gas is detected, and it is then too late for the application of any effectual remedy.. The best that can be done is to remove the injured tree and plant a healthy one in its stead, and even this will not always prove a success, as it is difficult to remove all the poisoned earth, and it usually requires several renewals before a healthy growth is secured. Gas poisoning is the unsuspected cause of many deaths among city trees."

In Philadelphia the loss of street trees by this cause has been enormous. Why should not the gas companies be made amenable, says the *Gardener's Monthly*, for these losses? It ought to be, and it is just as practicable to make a gas pipe gas-proof underground as above. And then look at the enormous loss to the tax payers by leakage of gas in this way.

A NEW SOUTH WALES (Riverine) paper says that six merino rams, shorn lately by Messrs. Nichol & Son, of Beckwith Court, near Clunes, gave the very handsome return of 76¼ lb. of wool.

CRYOLITE AND ITS USES.

By Willis Brenton, Ph.G.

[From an Inaugural Essay presented to the Philadelphia College of Pharmacy.]

The natural deposits of cryolite of any importance, as far as known, are in the Ural mountains between Russia and Siberia, and on the western coast of Greenland, the latter being the great source of our cryolite and the only place where it is mined and exported to any great extent. The deposits at Miask in the Ural mountains are comparatively small and quite impure, in combination with mica, fluor spar, etc., and being so far from civilization—in a mountainous wilderness, with very poor natural facilities for transportation—they have not as yet been of any particular use to the world.

The Greenland deposits are remarkably pure and quite accessible. The veins, of a depth of 80 feet usually, are near the surface and extend along the cliffs for many hundred feet. At this place the Danish Government has established a colony, and the mineral is extensively mined and shipped to Denmark, and also to the United States. It was first brought to notice by a missionary who took specimens to Copenhagen, where it was analyzed and afterward imported as a source of crude soda for use in the manufacture of soaps.

Cryolite is a beautiful mineral. It generally occurs in great white masses, partially transparent, of a crystalline structure, and has very much the appearance of snow-ice, from which it has undoubtedly received its name, the Greek word *kryos*, signifying ice. Cryolite has come to be quite an item of commerce in this country, and is now imported in quantities of many thousand tons yearly. For this purpose many vessels are employed. It is not often that a vessel can make more than one voyage a season, on account of the floating ice in the Northern waters. So it must necessarily take quite a fleet to get out sufficient cryolite to supply the great demand. As imported to this country, the mineral contains very few impurities. In fact, I believe there is a contract with the Danish Government, and only a certain percentage of impurities are allowed. Each cargo is inspected before unloading, and if not up to the standard is rejected. When it is mined at a good depth, say 80 or 100 feet from the surface, it is very pure, whole cargoes containing but ¼ per cent. of impurities. In some of the mines, as they descend, the mineral becomes of a darker color. But a peculiarity about it is that on exposure, or when subjected to heat, the color is entirely dissipated, leaving the cryolite perfectly pure. The impurities of cryolite generally consist of carbonate of iron and sulphides of copper, iron and lead, the latter in very pretty crystals. In some specimens traces of gold and several rare metals have been found, and quartz crystals occur often in connection with it.

Cryolite, chemically considered, is a double salt of aluminum and sodium with fluorine, the formula being $3NaF.AlF_3$ (Bloxam's chemistry). It can be artificially prepared by mixing calcined alumina and carbonate of soda with an excess of hydrofluoric acid.

Cryolite is not very hard, and can be easily reduced to a fine powder. In this condition, mixed with sand in the proportions of one part to three or four of sand, it has come into use in the manufacture of a beautiful white glass or porcelain ware, which is easily moulded and cut and is remarkable for its tenacity.

It could be used for many purposes if the advantages were sufficient to pay the difference in cost of importation.

As a source of soda, it is very profitable on account of the large percentage which it contains (about 35 per cent.) and the ease with which it is separated. The alumina present in it is no small item, and is now extensively used in the manufacture of the alum salts, which, as prepared from cryolite, are quite free from iron, generally containing but a trace. In the manufacture of the metal aluminum, cryolite has been used to a certain degree. But the process of isolation is not perfect, and I believe does not pay very well. Cryolite is insoluble in water, but, when long boiled with lime, decomposition gradually takes place. It is fusible at a red heat, and on cooling forms a kind of glass which is slightly soluble in water. To thoroughly separate the mineral into its constituents, it is first necessary to convert it into a soluble compound, which is readily accomplished, in a large way, by first bringing it to a very fine state of division by passing it through a crusher, then through several mills of different degrees of fineness, after which it is passed through sieves and bolting cloth, making it as fine as flour. It is then mixed with about an equal weight of lime, and calcined at a dull red heat in a reverberatory furnace for several hours, when it assumes a grayish appearance, being decomposed into insoluble fluoride of calcium and soluble aluminate of sodium, besides a small percentage of carbonate and hydrate of sodium. These are then separated from the fluoride of calcium by lixiviation with hot water.

On passing carbonic acid gas through the solution, the acid unites with the soda, and the alumina is precipitated, leaving carbonate of sodium in solution. Aluminate of sodium is now manufactured to a considerable extent, and is used in the place of soda and potash lye in the making of soaps, and is considered superior to either as a detergent. Fluoride of calcium, the by-product in the manufacture of soda from cryolite, is used in large quantities as a flux in the reduction of iron, gold, and other metals. Taking everything into consideration, the process of making soda from cryolite has many advantages over the old process of making it from barilla, the ash of marine plants of southern Europe, or from kelp, the ash of seaweeds. It generally takes about 24 tons of seaweed to make one ton of barilla or kelp. The percentage of soda in barilla is 25 per cent., and in kelp not over 7 per cent. They are used only in the manufacture of iodine now. About the year 1804, Leblanc discovered and introduced the process of making soda from sea salt or chloride of sodium. It is rather complicated, and consists of heating the salt with sulphuric acid to form sulphite of sodium, roasting this with limestone to convert it into an impure carbonate, which is afterwards washed and purified. The extensive soda manufactories of England all make it from salt by this or similar processes, producing bicarbonate often containing more impurities and a smaller percentage of carbonic acid than that produced in this country from cryolite.

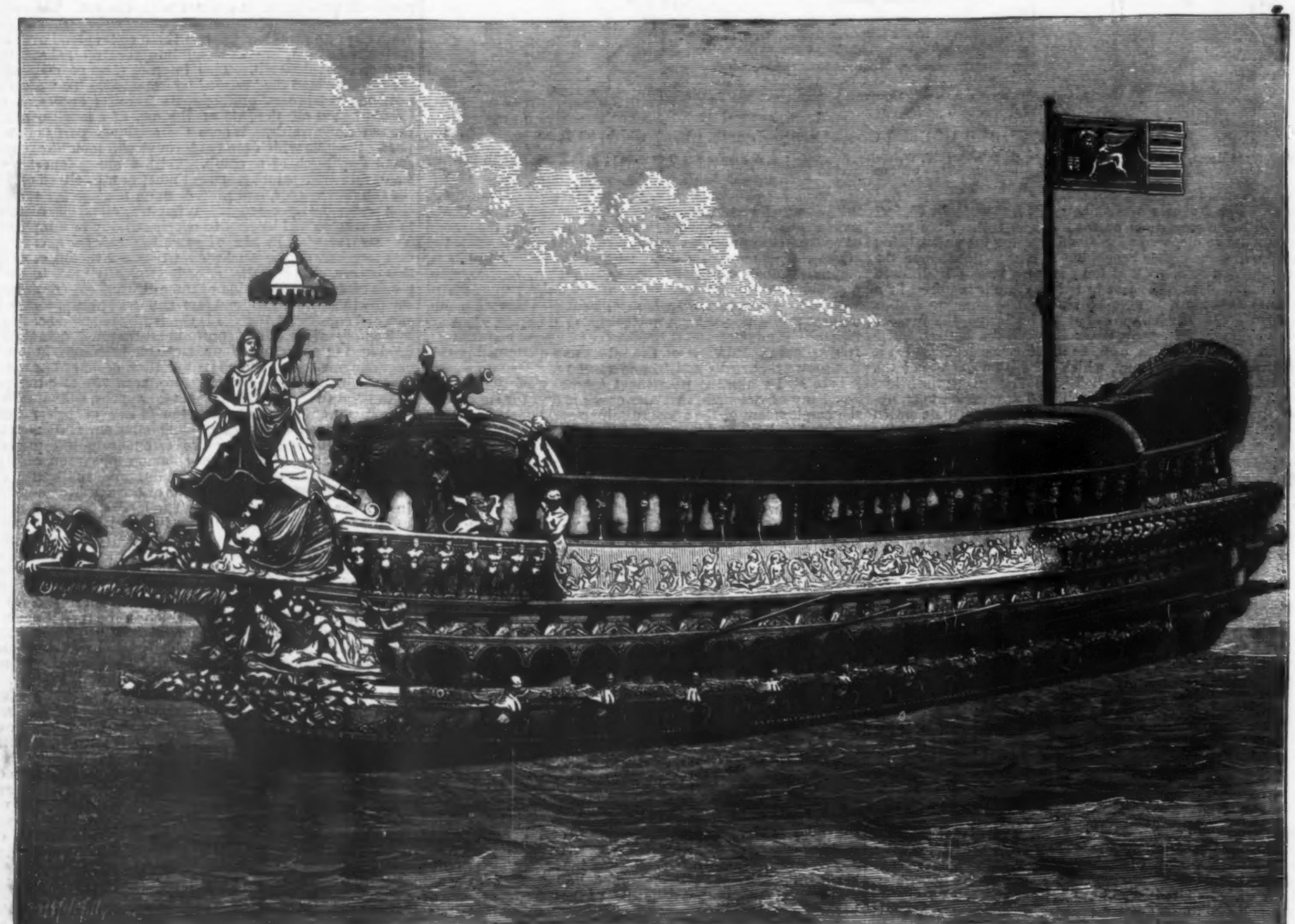
A Paris Church Damaged by Lightning.—The little Gothic church of Kernaschen in the commune of Saint-Carade-Tregomel, built by Alain de Rohan in the fifteenth century, was lately nearly totally destroyed by lightning. The steeple was struck and fell through the roof, crushing in its fall fretwork and pinnacles, and doing much damage to the sculpture in the interior.

THE BUCENTAUR.

In the accompanying engraving is represented the famous Bucentaur or galley wherein the Doges of Venice went in great state to celebrate the wedding of the city to the Adriatic. This ceremony, symbolical of the Venetian supremacy on the sea, was first performed by the Doge Sebastiano Ziani in the 12th century, and the right to do so was bestowed upon him, with many other marks of dignity, by Pope Alexander III., whom he supported in a long war against the Emperor of Germany, Frederick Barbarossa. Of the original vessel nothing remains but a few fragments, but there exists many models and pictures, dating from the period of its construction, which are carefully preserved in the Arsenal Museum of Venice, and from which our illustration was prepared.

In the construction of the boat the greatest artists of the day vied with each other to render it a marvel of beauty. Carving and gilding, and exquisite ornamental painting, were lavished upon it, and it was hung with draperies of the richest fabrics. On the day appointed for the ceremony, the workmen of the Arsenal claimed the privilege to act as oarsmen. The Grand Admiral of the State took the helm, and as he was required to take a solemn vow to return the Doge and the great nobles on shore safe and sound, he had the right, in case the weather was stormy, to forbid the vessel proceeding beyond the bar of the Lido.

On the open Adriatic being reached, amid the thunder of cannon, the shouts of thousands of people who filled the gondolas that thickly clustered about the galley, and the pealing of the bells of Venice, the great vessel was slowly turned stern toward the sea. Then the patriarch, leaving his seat beneath a superb canopy of purple and gold, received the massive ring, on which was engraved the lion and scroll of St. Mark, blessed it, and dipping a vase in the sea filled it with water. Approaching the Doge, he presented both ring and vase, who, in turn, advancing and pronouncing solemnly the marriage words, cast the ring overboard, completing the ceremony.



VENETIAN MARINE ARCHITECTURE. THE BUCENTAUR.

With the fall of the Venetian Republic, in 1797, this curious proceeding was discontinued; and the Bucentaur was itself destroyed by the French, under Bonaparte, in that year. We are indebted to *Le Monde Illustré* for the engraving presented.

The reader will notice that there is a striking analogy between the general construction of the vessel and that of the large double decked passenger steamboats which ply upon our rivers. The Bucentaur has the curved roof which is constantly found on modern steamers, and the mode of supporting the decks by arches and a multiplicity of columns is that now commonly used. In fact, it would be necessary merely to take one of the large propeller barges which are employed for freight purposes on the Hudson river, decorate it in the lavish manner represented in our engraving, and a very fair reproduction of the Bucentaur would be obtained, and which would chiefly differ from that vessel in its 19th century steam propeller, instead of the 16th century long oars.

The Cathedral of Rheims is to be restored at a cost of more than $400,000. It was begun in 1212 from designs by Robert de Courcy, and was finished about 1430. Its predecessor dated from the ninth century.